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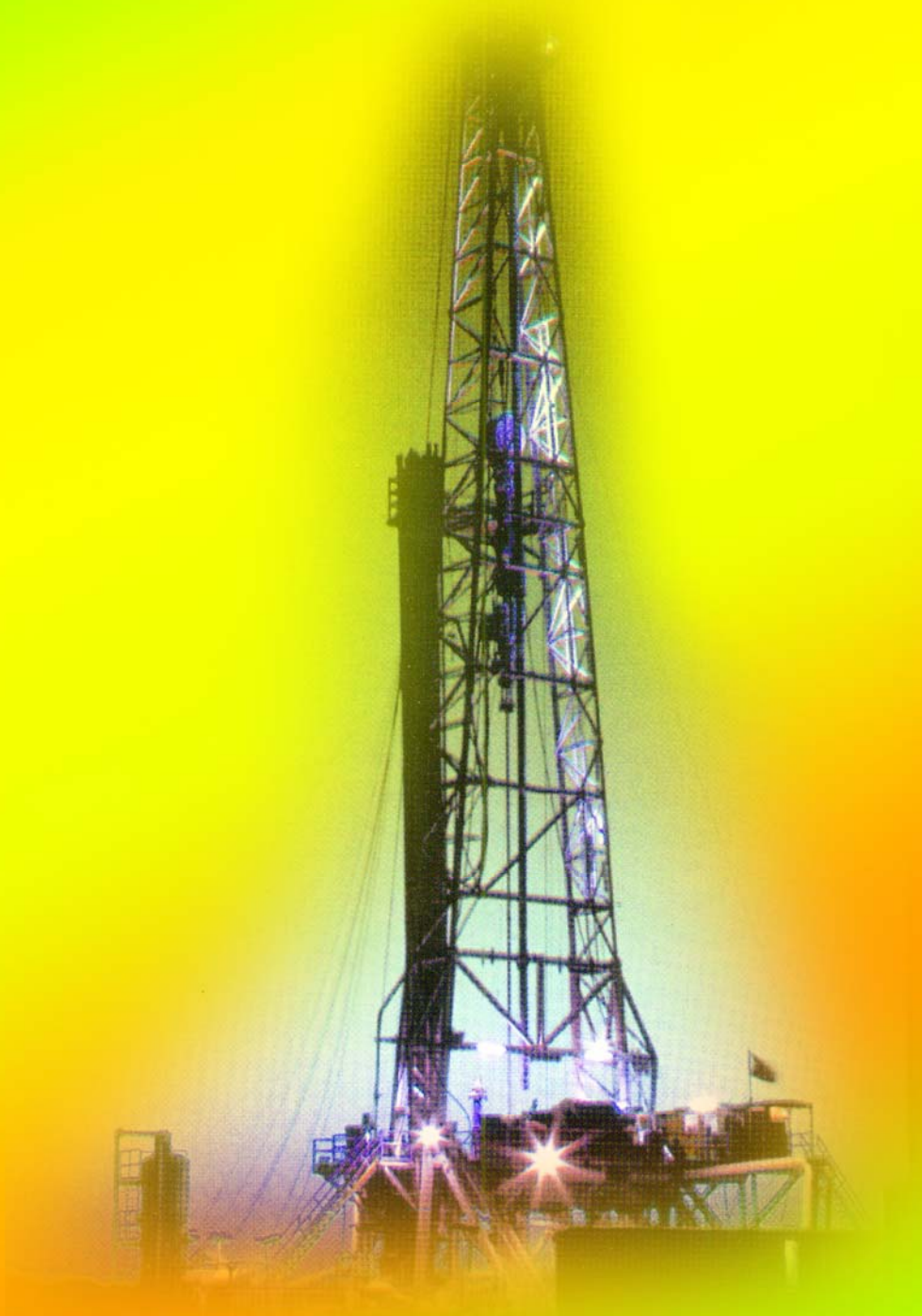
ONGC

Oil and Natural Gas Corporation Limited

Cauvery Asset, Karaikal.



RIG EQUIPMENT MANUAL

December 2006

Oil and Natural Gas Corporation Limited

Cauvery Asset, Karaikal

RIG EQUIPMENT MANUAL

Compiled By

K.Chelladurai
SE (M), DS

December 2006

Oil and Natural Gas Corporation Limited
Cauvery Asset

FOREWORD

The manual **"Rig Equipment Manual"** contains voluminous technical information about Rig Equipment. This technical information is of much use to field engineers for day-to-day operation and maintenance of Rig Equipment. I hope this manual will certainly help the engineers to uncover hidden potential, enhance their talent, skill and confidence level for collective success of the team. Employees would always aspire to find a better and more efficient way to work. By making use of this manual, the user can update his/her technical knowledge and skills to face challenges. I am sure this special issue on **"Rig Equipment Manual"** being brought out by **Shri. K. CHELLADURAI, SE (MECH**) at a very appropriate time will enlighten the engineers about the operation and maintenance of equipment with high spirit.

I wish him great success.

ANIL JOHARI
GGM-Asset Manger

PREFACE

The manual **"Rig Equipment Manual"** is prepared and compiled for field engineers and their team members. This manual is for better understanding about the system functions, safe operations and upkeep of equipment. The main objective of compiling this manual is to motivate the field personnel for professional advancement, and also for safe and healthy work practice. It is useful not only to maintenance engineers but also to operators for developing technical skills and knowledge about functions of equipment for safe operation. I hope this manual is of much use to field engineers and they make use of it. I wish them all the best with my heartiest pleasure. This manual has been thoroughly **revised, incorporated with more information and edited a second** time.

I wish to acknowledge the assistance that I have taken in preparing and compiling this manual from various textbooks, manuals, training course materials, experience etc. It is a pleasure to express my thanks and gratitude to all those authors and publishers.

I am especially thankful to **Shri. Anil Johari, GGM-Asset Manager, Shri. A.K. Khanna, DGM (D)-HDS** and **Shri. T.R. Sivakolundu, CE (M)**, DS for their encouragement and cooperation in bringing out this manual.

I am grateful to my family members for their active cooperation for completion of this manual.

K.Chelladurai
SE (MECH), DS

"TRAINING HELPS TO ENCOURAGE THE BEST AND DEVELOP THE REST"

ABSTRACT

BHEL make E-760 and E-1400 series of deep drilling rigs are deployed at different locations of Cauvery asset, Karaikal for drilling activities. These Rigs are having drilling capacities of 3600mts and 4900mts respectively. These Rigs are equipped with CAT D399 Engines; BPCL Mud Pumps, ELGI and KHOSLA make Screw and Reciprocating Compressors, Ingersoll Rand Air Winches, Top Drive, Independent Drive etc. This manual mainly describes various functions of equipment and their importance to the drilling activities. It is presented in the most compact and lucid form. It will enhance confidence level of an individual for proper operations and maintenances of equipment with out any difficulties. It will also help engineers to enhance problem-solving capabilities and ensure safety of personnel and equipment. Various important parameters are also given in this manual for better diagnosis and to eliminate the problems forthwith.

This manual is prepared and compiled based on the problems faced by field technicians, engineers and operators of the rigs. Of course, it must be very useful to them.

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CLASSIFICATION OF DRILLING RIG EQUIPMENT

RIG MODEL: E-760

- E- Electric drive.
- 760- Draw works power rating in kW/1000HP.
- Maximum drilling depth: -------3600 mts
- Drill pipe size-------41/2"
- Maximum load carrying capacity: ---190tonnes

RIG MODEL: E-1400

- E- Electric drive.
- 1400- Draw works power rating in HP (1400HP).
- Maximum drilling depth: -------4900 mts
- Drill pipe size-------41/2"
- Maximum load carrying capacity: ---190tonnes

Rig equipment can be divided into five categories.

- Power producing equipment.
- Hoisting equipment
- Rotating equipment.
- Fluid circulating equipment
- Auxiliary equipment

1. Power producing equipment

- Power packs
- Compressors

2. Hoisting equipment

- Draw works
- Crown block
- Traveling block

- Hook
- Air winch

3. Rotating equipment

- Rotary table
- IRD
- Top Drive System
- Swivel

4. Fluid circulating and conditioning equipment

- Mud pumps
- Hopper
- De-sander
- De-silter
- Shale shaker
- De-gasser
- Mud agitator
- Mud mixture

5. Auxiliary equipment

- Water pumps
- Diesel lifting pump
- Welding transformer
- Lighting

I.POWER PRODUCING EQUIPMENT

1. POWER PACKS

ONGC Drilling Rigs are mainly powered by Caterpillar make D399 model engines. These engines are the source of power to the Drilling Rig Equipment. Hence engines are considered to be heart of the Rig. Each Rig of E760 Model having three power packs and E1400 Model having four power packs. These power packs can be put into operation individually and parallels with common bus bar provision. These power packs produce mainly AC current. Part of the AC is converted into DC with help of silicon control rectifier. This DC input is required for variable speed drive motors of mud pumps and draw works. AC is required for all other constant RPM motors.

CATERPILLAR ENGINE

Engine model: ---------- D399
Engine rated RPM ------- 1000RPM
Engine rated HP -------- 1010HP

The inlet air, fuel, lubrication and cooling systems are the most important and critical part of four stroke diesel engines. If all these systems are maintained properly, the engine's reliability, availability and optimum performance are ensured. The details of each function are elaborately given below for better understanding about engine for proper operation and maintenance.

A). AIR INDUCTION SYSTEM:-

The maximum power developed by a diesel engine largely depends upon the cubic capacity of the engine and the engine's ability to receive the maximum amount of cool, clean, fresh and dry air for complete combustion of fuel. Restriction of air if any in the air induction system result improper burning or unburned fuel goes to exhaust in the form of black smoke causing power loss, overheating problem and high exhaust temperature.

The purpose of using an air filter is to remove harmful dirt and impurities from the air rushing into the engine. The dry type air filter is the most efficient type of air filter and its efficiency is around 99.5%, wet type filter efficiency is 93.5%. In case the pressure difference across air filter element shows more than1psi then the filter element needs replacement.

The two turbochargers of CAT engine D399 provide a cross air blowing to inlet manifolds. These results in minimum air flow restriction (due to long bend pipe) in the after cooler and assure equal quantities of air to each bank of cylinders. The after cooler removes the heat from the compressed air as it passes through after cooler to increase the density.

TURBOCHARGER:-

The purpose of turbocharger is to charge (boost) more air into the engine cylinders. It helps the engine to provide more power by burning more fuel in a given time. The waste going exhaust gas drives the turbocharger without any extra input. The turbocharger increases the pressure of inlet manifold air 3 to 4 times more than atmospheric pressure is called **boost pressure**.

With turbocharged engines, there is a small time lags between the Engine speeds, throttle and boost pressure of turbocharger. This results black smoke during starting and acceleration of engine. The turbocharger speed can vary between **70000 to 85000 rpm**.

Turbo compressor performance is sensitive to the presence of dirt and other deposits. Bearing design and precise balancing of the whole rotating assembly are of paramount importance in ensuring a long life for the unit. Allowing deposits to build up on the compressor wheel can cause wheel imbalance, seal damage and ultimately jammed.

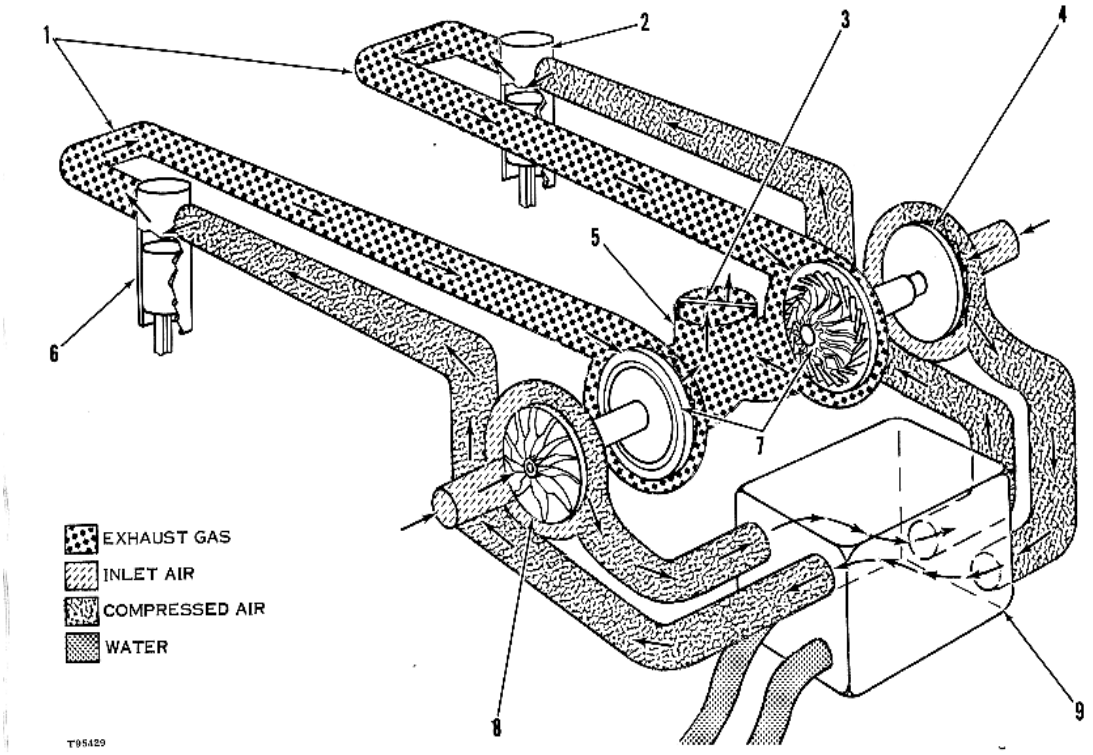
The full floating bearings manufactured from an alloy of copper-tin-lead are a critical lubrication point. It is necessary to ensure oil supply to them almost immediately after the engine starts.

A choked air cleaner can also cause a vacuum in the suction side of the compressor wheel leading to leakages in the seals of the turbocharger and allowing oil to be thrown into the intake manifold, causing more lubricating oil consumption and blue exhaust smoke. Hence timely changing of air cleaner element is paramount important not only for long life of turbocharger but also for engine life.

NOTE:

All turbocharged engines must be idled for 3-5 min. time immediately after startup and before shutdown. This ensures lubrication and cooling of the bearing, shaft, seals and bearing housing etc. It helps us to increase turbocharger-operating life.

AIR INLET AND EXHAUST SYSTEM



AIR INLET AND EXHAUST SYSTEM

1 Exhaust manifolds
2 Right cylinders
3 Diffuser plate
4 Right turbocharger impeller
5 Exhaust elbow
6 Left cylinders
7 Turbocharger turbine wheels
8 Left turbocharger impeller
9 After cooler

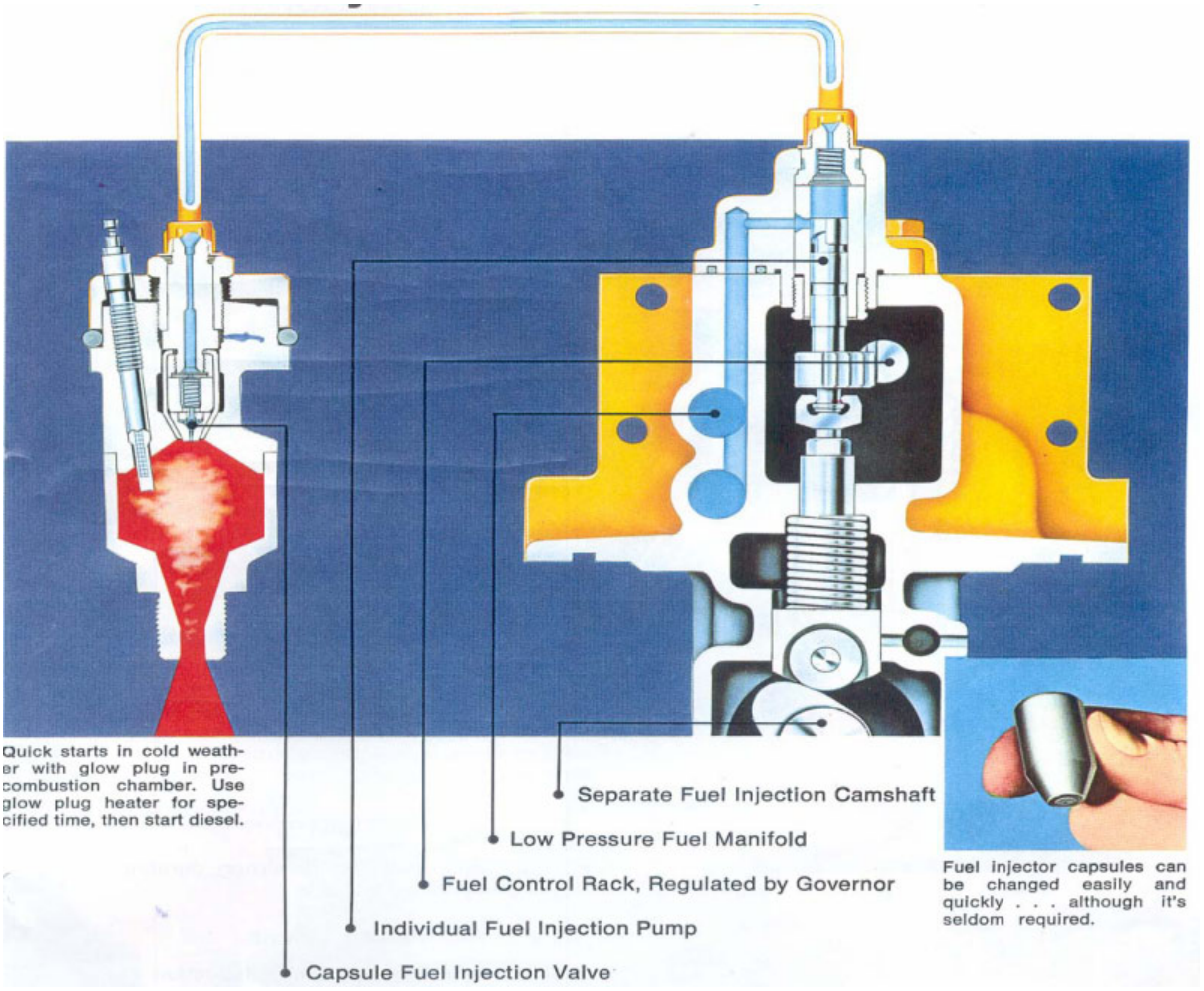
INTAKE AIR TEMPERATURE:-

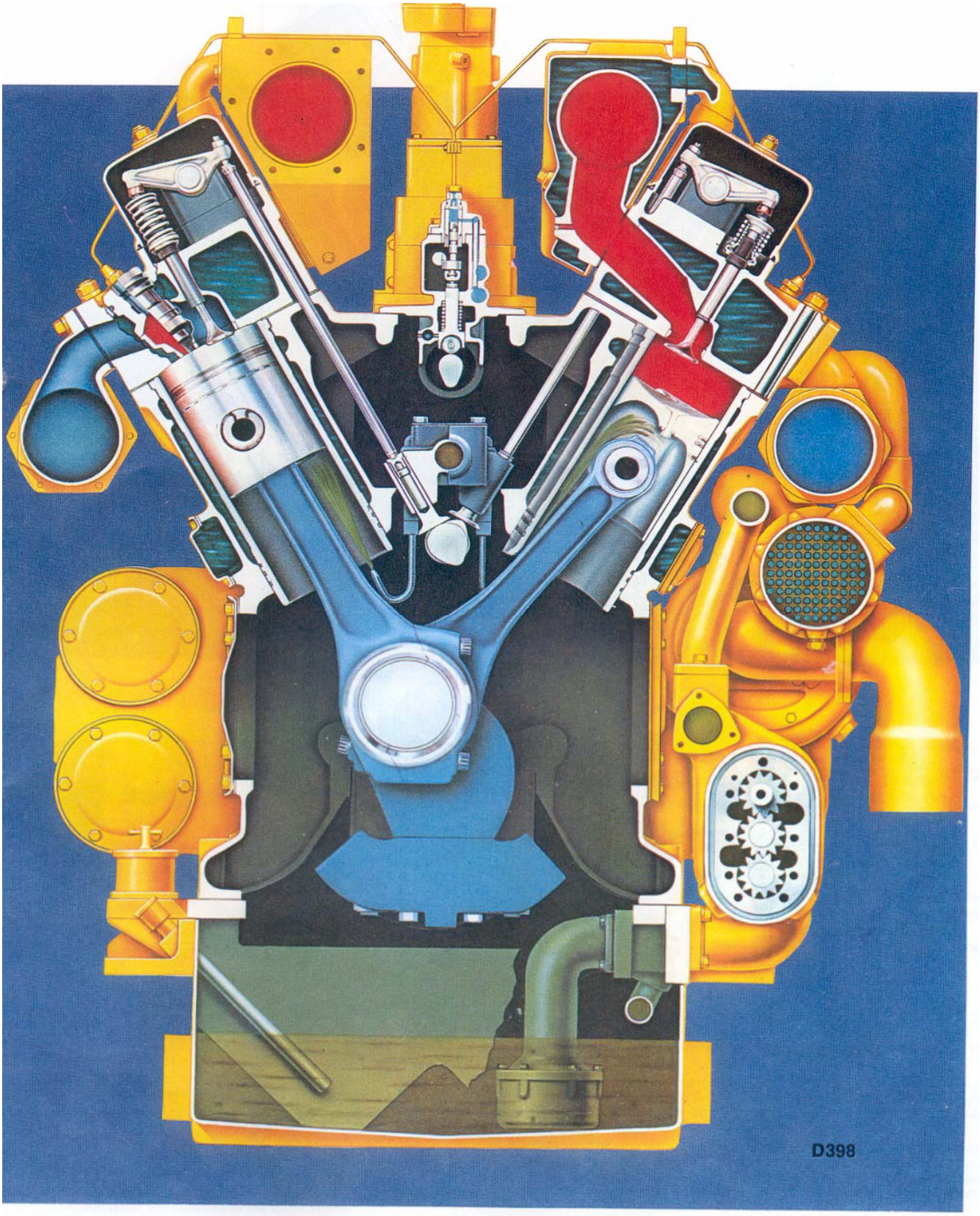
Air molecules expand at high temperature occupies the areas with less density. This less density (hot compressed) air provides inadequate quantity of oxygen molecules to the cylinders. It is not enough for complete combustion of fuel in the cylinders and increases the exhaust temperature. Hence high intake air temperature of the engine is undesirable for proper combustion.

The after cooler removes some of the heat from the compressed air of turbochargers. This inlet air temperature is lowered to the engine coolant temperature. The exhaust manifolds are water shielded to avoid heat radiation to the engine body and inlet manifold.

NOTE: If the intake air temperature increases by 1 degree then exhaust temperature will increase by 3 degrees.

B). FUEL SYSTEM:-


Quick starts in cold weather with glow plug in precombustion chamber. Use glow plug heater for specified time, then start diesel.
Separate Fuel Injection Camshaft
Low Pressure Fuel Manifold
Fuel Control Rack, Regulated by Governor
Individual Fuel Injection Pump
Capsule Fuel Injection Valve
Fuel injector capsules can be changed easily and quickly . . . although it's seldom required.


D398

SCHEMATIC OF FUEL SYSTEM

1 Fuel transfer pump inlet line
2 Fuel priming pump
3 Fuel passage
4 Inlet from tank
5 Fuel return line
6 Fuel tank
7 Fuel transfer pump outlet line
8 Fuel transfer pump
9 Fuel filter housing
10 Fuel injection pump housing

FUEL SYSTEM:-

The basic function of the fuel system is to supply the fuel to the cylinders in the right quantity, at the right time and at right pressure to atomize thoroughly.

Fuel produces the power in a diesel engine when it is atomized and mixed with hot air in the combustion chambers. Pressure caused by the piston risings in the cylinders causes a rapid temperature increase. When fuel is injected, the fuel/air mixture ignites and the energy of the fuel is released to force the pistons downward and turn the crankshaft. A perfect fuel would burn completely, leaving no residue or smoke products. However, there is no perfect fuel.

CETANE NUMBER:-

- ✓ Cetane number is a measure of the ignition quality of a fuel.
- ✓ Higher cetane rating assures ease of starting in most conditions.

POUR POINT:-

- ✓ The pour point of a fuel is an indication of the minimum temperature at which the fuel will flow.

CLOUD POINT:-

- ✓ The cloud point is the temperature at which some of the heavier paraffin components (wax) in the fuel start to form crystals. This wax can plug the filter.

NOTE: Heat changes the volumetric efficiency of fuel resulting in a 1% power loss for each 6°C above 38 °C

CATERPILLAR FUEL SPECIFICATION:-

Sl. no.	Requirement	Preferred	Permissible
01	Cetane no. for pre-combustion engine	35 minimum	35minimum
02	Cetane no. direct injection engine	40minimum	40minimum
03	Water & sediment	0.1% max.	0.5max.
04	Pour point	10°F below ambient temperature	
05	Cloud point	Not higher than ambient temperature	
06	Sulfur	0.5% max.	0.5%max.

C). LUBRICATION SYSTEM:-

Oil is the blood of an engine. The lubricating oil has to perform several basic functions during engine operation.

1. Clean
2. Cool
3. Seal
4. Lubricate
5. Support and
6. Protect.

NOTE: During engine startup the pre-lubrication pump is activated by compressed air and sends oil into the engine lubrication system until

there is a low oil pressure of approximately 3psi is developed mainly in the turbocharger line. The pressure sensing switch in the vee of the engine closes the air to pre-lub. Pump and allows the air to the motor to be activated for starting the engine. Oil pressure regulating valve is the first component in the engine body to receive oil from the oil pump. This valve controls the maximum pressure of the engine oil in the lubrication system.

D). COOLING SYSTEM:-

The cooling system is basically a heat regulating system. It maintains the temperature of the coolant by dissipating the excess heat to atmosphere so as to keep the engine at normal operating temperature. Normal operating temperature ensures the best fuel economy, peak engine performance and also keeps engine parts within the designed working tolerances. Temperature regulator controls the coolant flow to the radiator to regulate the temperature in the cooling system. The temperature difference between jacket water and radiator is 7 to 11^{o}C. The small vent line on the top of the outlet of the housing is connected to the inlet of the water pump. The cooling water pressure is approximately 7psi when the engine is on load.

pH VALUE

pH value is the inverse of log concentration of H^+ ion

pH value range is 1 to 14

pH > 7 basic

pH < 7 acidic/alkalic

pH value 7 is neutral(6 to 8 is neutral)

PH value 6.5-to1 progressively more acidic, attack on ferrous metal.

Avoid keeping coolant this range

pH value 8 to 14 progressively more alkaline attack on non-ferrous materials

Avoid keeping coolant above pH11.3

Desired range is between 8 to 10.5

EFFECT OF SULFUR IN ENGINE PERFORMANCE:-

During the combustion process, sulfur dioxide (SO_2) and sulfur trioxide (SO_3) are formed. These oxides of sulfur combine with the water vapor formed acid during combustion. This acid accelerates corrosive wear in the engines body components and increases the chance of early engine failure. Hence **sulphur is the silent enemy of the engine.**

Oil has an affinity for oxygen at high temperature. This tendency leads to oxidation of oil at higher temperature and increase the viscosity. Due to oxidation, the longer the oil is used more the viscosity of oil. High viscous oil is not desirable for better lubrication. Viscosity is a measure of resistance to oil flow. Oil that is too viscous will have excessive resistance to flow at low temperature. Alkaline additives, called buffers are used to

prevent corrosive wear on engine parts caused by acids. The alkalinity of oil is referred to as **TBN.** The higher the oil's TBN, the greater is its capacity to neutralize acids. Caterpillar recommends that the TBN of new oil is to be 20 times as great as the percent of sulfur in the fuel being used. Corrosive wear can occur in any engine only after sulfuric acid has formed.

Engine temperature is an important factor in the creation of sulfuric acid. The exhaust gas containing sulfur oxides must combine with water to form sulfuric acid. Therefore the engine should operate above dew point temperature to minimize acid formation. Low engine operating temperatures provide ideal conditions for sulphuric acid condensation. High humidity levels in combustion air supply the water necessary to form acid.

Another factor that determines the quantity of acid formed is the amount of fuel used during an oil change interval. During combustion, the fuel's sulfur is converted to sulfur oxides. Naturally, the more fuel consumed during an oil change interval, the more sulfur oxides are available to form acids.

FACTORS AFFECTING ACID FORMATION:-

1. Fuel sulfur content
2. Engine temperature combustion air humidity
3. Fuel consumption
4. Clean oil addition

INDICATORS OF CORROSIVE WEAR:-

- Increased oil consumption
- Crankcase blow-by
- Vapor in blow-by
- Blue exhaust smoke

Acid attacks cylinder liners, piston rings, exhaust valve guides and other engine parts. When enough corrosive wear has taken place, you will probably notice increased oil consumption, more blow-by and vapor in the crankcase. Blue exhaust smoke may also occur as a result of acid attacks.

E).EXHAUST SYSTEM REQUIREMENTS:-

The exhaust system of an engine plays an important part in the overall performance and efficiency of diesel engines as like the air, fuel, cooling and lubrication system does. It minimizes exhaust back pressure and reduces noise.

EXHAUST SMOKE:-

Exhaust smoke is the best indicator for the operating condition of engine.

BLACK SMOKE:-

Block smoke indicates improper burning of diesel fuel inside the combustion chamber. If air is less or diesel is more it causes improper burning of diesel and therefore black smoke.

Ex: If air filter is choked, the amount of air needed for the amount of diesel sprayed, will not be available for combustion, leading to improper burning of diesel, which comes out of the exhaust as carbon particles or block smoke.

WHITE SMOKE:-

When water vaporizes inside the combustion chamber it comes out in the form of white smoke from the exhaust.

Ex. If the cylinder head is cracked or if the nozzle adapter is broken it causes water to enter the combustion chamber and leads to white smoke.

BLUISH SMOKE:-

When lubricating oil burns inside the combustion chamber engine will emit bluish smoke. Lubricating oil can enter the combustion chamber through the piston rings and liner, from the turbocharger seal, from the valve guides and if the oil level is kept more than "full" mark on the dipstick.

Note: Turbocharger seal failure normally occurs due to air filter choke.

GRAY OR ASH COLOUR SMOKE:-

Gray or ash colour smoke is a combination of bluish and white smoke. This means both engine oil and water is burning inside the combustion chamber.

PURPLE SMOKE:-

If engine operates in the vicinity of hot springs or in surroundings with high sulphur content it will cause purple smoke from the exhaust, this is very dangerous and harmful for the engine.

BARELY VISIBLE HAZE:-

When the engine operates, the exhaust can be seen as a clear haze, against any background, this means combustion is perfect and all systems are working as per the design and the engine is in the best operating condition.

SCHEDULE OIL SAMPLE:-

- ✓ The atomic absorption spectrophotometer measures the engine wear particles in suspension in the used oil.
- ✓ Infrared analysis to determine the condition of used lube oil. The IR test compares a used oil sample against a new oil sample.

- ✓ This test can measure the presence of additional sulfur products and soot, as well as oil oxidation.
- ✓ Each oil sample should be taken when the oil is hot and well mixed.

VALVE LASH ADJUSTMENT:-

Two revolutions are required for completing the tappet settings. Putting the engine in one of two positions can do the adjustments of valves mentioned against the particular position. Turn the flywheel in the direction of engine rotation (anticlockwise rotation when viewed from flywheel) until No.1 piston is at top center on the compression stroke as indicated by the flywheel-housing pointer. Align the TDC1 timing mark for the engine with the timing pointer on the flywheel housing. On the compression stroke both valves will be closed. Valve clearance is measured with a feeler gauge put between the rocker arm and the valve stem tip. Check the tappet clearance in the inlet valve upto 0.015inch and exhaust valve tappet clearance upto 0.035inch and adjust accordingly.

IMPORTANT POINTS TO REMEMBER:-

- ✓ Inlet valve diameter is greater than exhaust valve diameter to allow more air into combustion chamber in a given time.
- ✓ Exhaust valve tappet clearance is more than inlet valve tappet clearance to accommodate expansion of exhaust valve stem due to high temperature.
- ✓ The timing of the fuel injection pump is correct when the timing pin goes into the notch in the camshaft and no.1 piston is on top center, compression stroke.

With No.1 cylinder on compression stroke

Counterclockwise rotation

Viewed from flywheel

Valves	D379 Cylinders	D398 Cylinders	D399 Cylinders
Exhaust	1-4-5-8	1-4-5-6-9-12	1-2-3-4-5-6-8-9
Intake	1-2-3-6	1-3-6-7-10-12	1-2-7-8-11-12-13-14

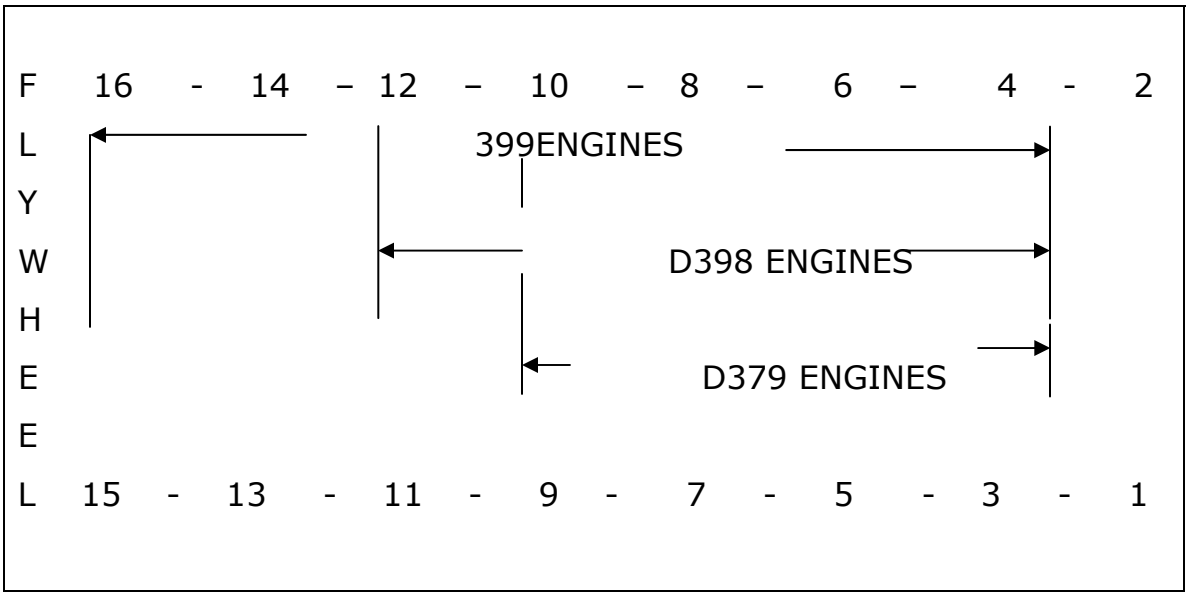
With No.1 cylinder on exhaust stroke

Counterclockwise rotation

Viewed from flywheel

Valves	D379 Cylinders	D398 Cylinders	D399 Cylinders
Exhaust	2-3-6-7	2-3-7-8-10-11	7-10-11-12-13-14-15-16
Intake	4-5-7-8	2-4-5-8-9-11	3-4-5-6-9-10-15-16

NUMBERING OF CYLINDER:-



HYDROMECHANICAL SHUTOFF SWITCH (SAFETY SYSTEM):-

The hydro-mechanical shutoff device gives protection to engine due to low lub. oil pressure, high coolant temperature, and engine over speed.

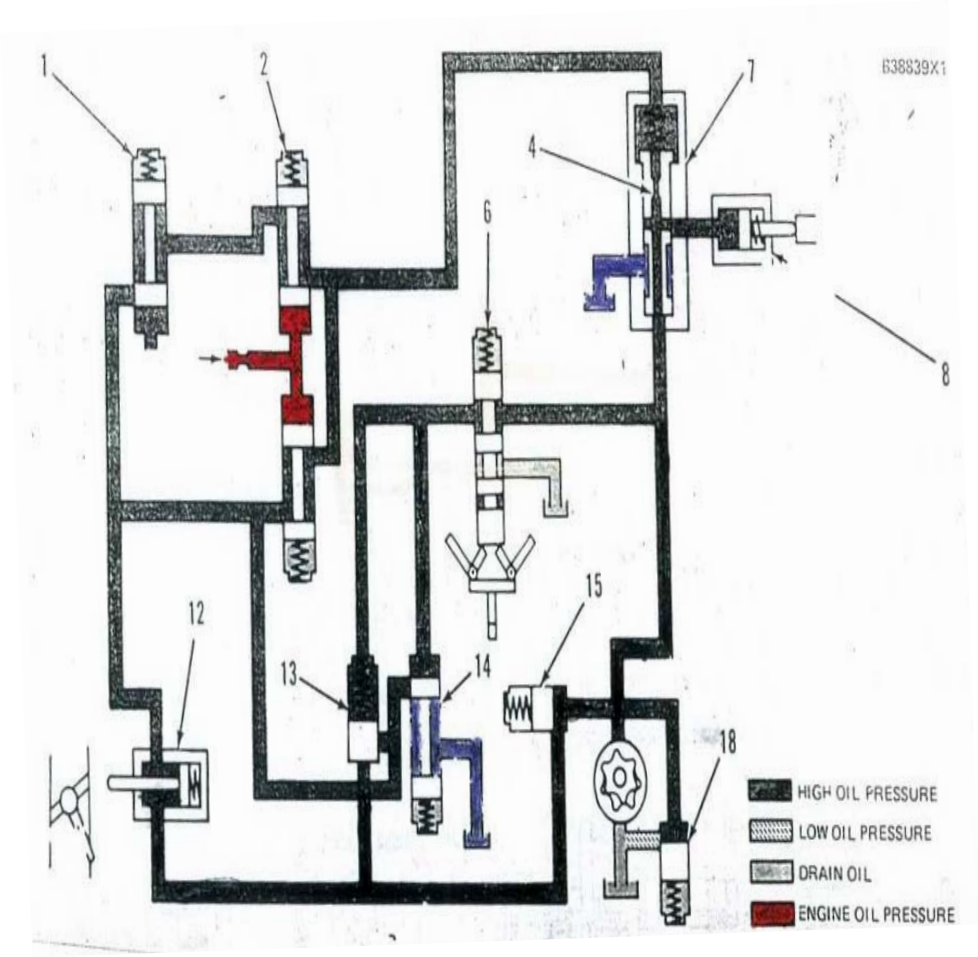
The shutoff valve has also a manual control to stop the engine. The fuel rack shutoff will move the rack to the fuel off position with either low oil pressure or high coolant temperature. Both the fuel rack and inlet air shutoffs will activate when the engine speed exceeds the setting speed (setting speed = 18% of rated speed + rated speed) or if the manual control is used. The fuel rack shutoff will reset automatically but the inlet air shutoff must be manually reset.

Oil pump pressure-----250psi
Oil pressure at the start of the rack circuit ---110psi
Oil pressure at the start of the air inlet circuit -----15psi
Rack sequence valve maintain rack circuit oil pressure of 110psi

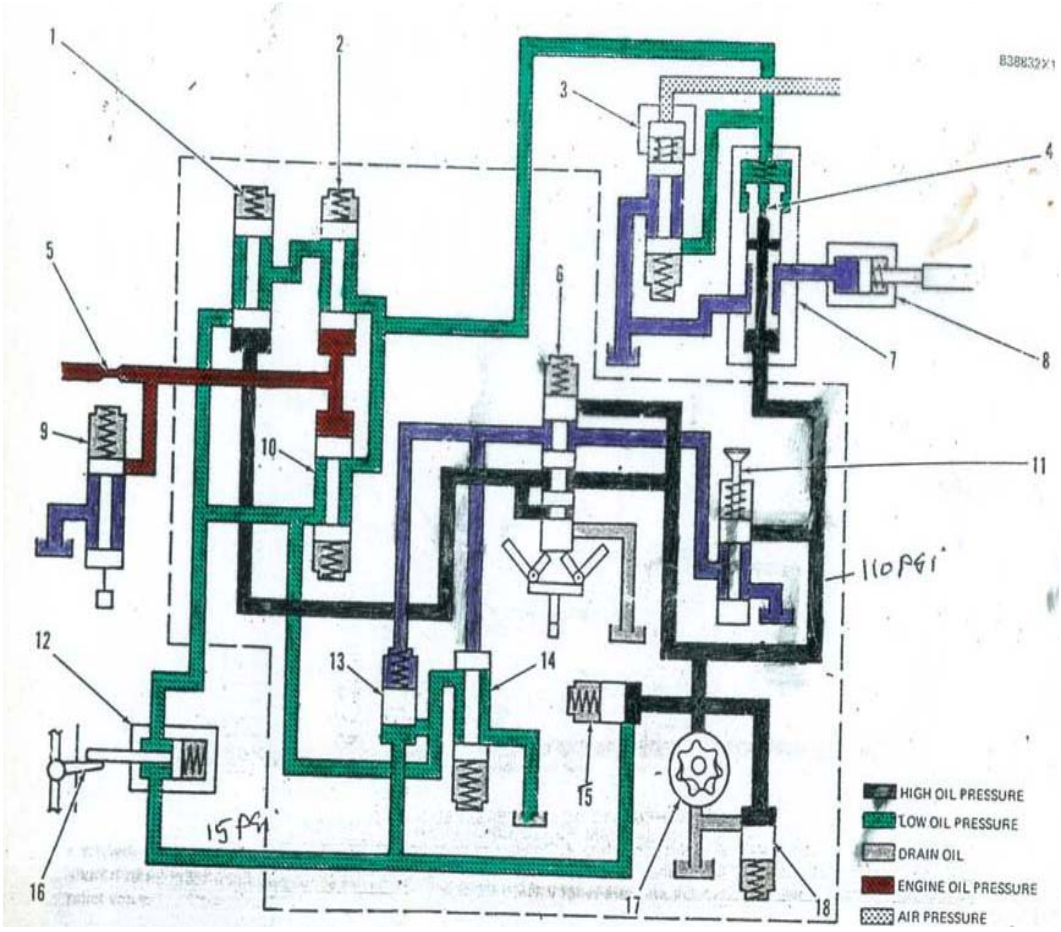
SENSING PARAMETERS:-

- ✓ Low speed, low lub.oil pressure sensing valve activate at minimum oil pr of 20psi
- ✓ High speed, low lub.oil pressure sensing valve activate at minimum oil pr. of 30 psi
- ✓ Thermostatic pilot valve activate at the water temperature of 99 ^{o}C
- ✓ Over speed sensing valve activate at the speed of 1180 rpm
- ✓ At approximately 70% of engine full load speed, the oil pressure protection changes from the low speed range to the high-speed range.

OVER SPEED FAULT:-

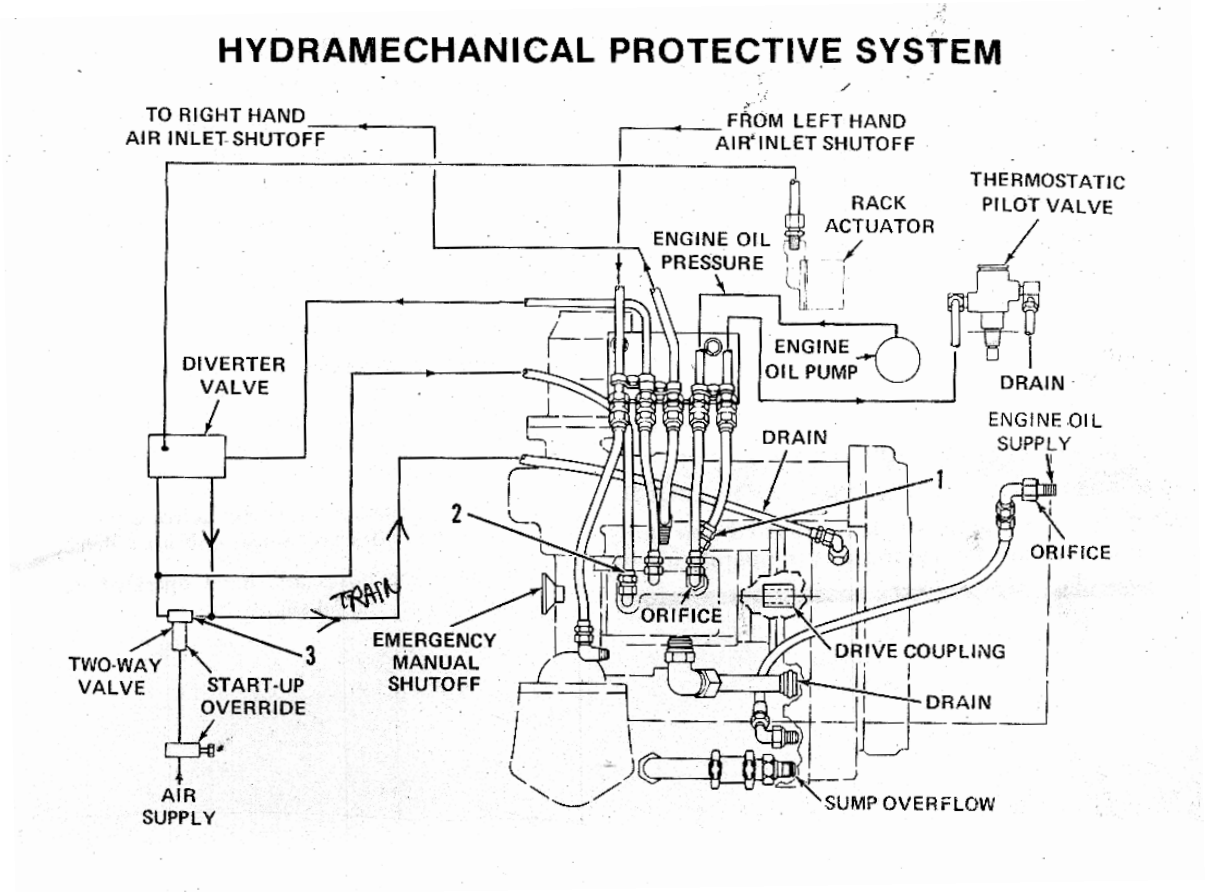


OVER SPEED (NORMAL OPERATION):-



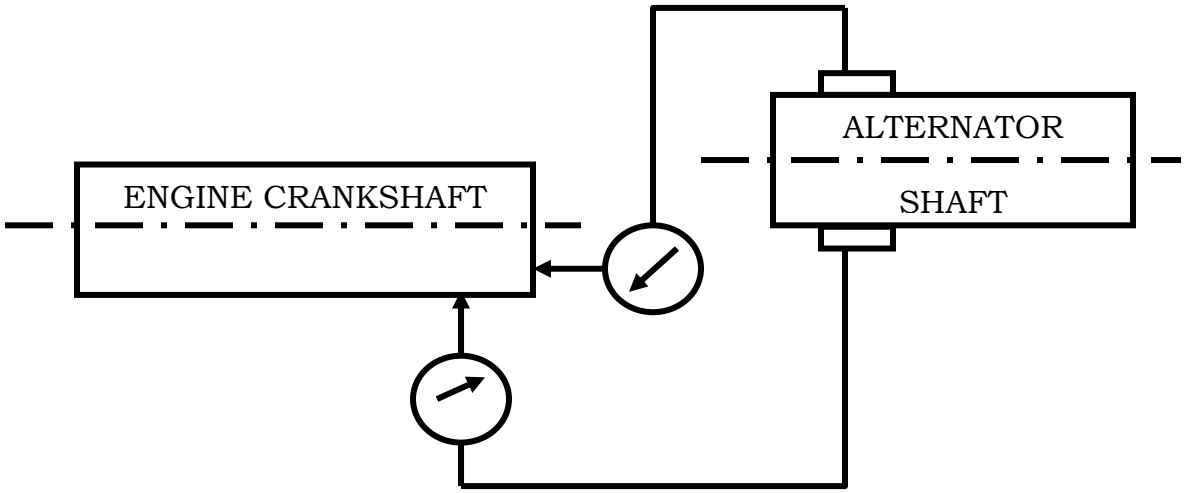
HMSO SYSTEM COMPONENTS

1 Selector valve
2 Low speed oil protection valve
3 Start-up override valve
4 Diverter valve orifice
5 Engine oil pressure orifice
6 Speed sensing valve spool
7 Diverter valve
8 Rack shutoff actuator
9 Thermostatic pilot valve
10 High-speed oil protection valve
11 Emergency manual shutoff valve
12 Air inlet shutoff actuator
13 Air inlet sequence valve
14 Pilot operated two-way valve
15 Rack sequence valve.
16 Air inlet shutoff valve
17 Oil pump
18 Oil pressure relief valve

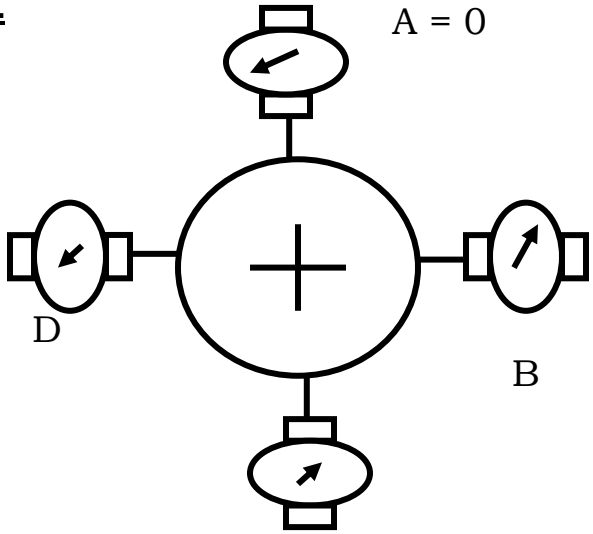


ENGINE AND ALTERNATOR ALIGNMENT:-

Set the dial gauge stand on the alternator shaft near flywheel or flywheel housing. Fix two dial gauges on the stand and set the dial gauge at zero by toughing the dial stem on the flywheel body radially as well as face at point A as shown in figure. Rotate the crankshaft either clockwise or anticlockwise, but follow only one direction till complete the alignment. Take reading at point A, B, C, and D. Add/remove the shims from alternator base and tight foundation bolts till the reading comes close to permissible limits given below. While taking face reading at points A, B, C, and D, push the crankshaft towards radiator end so as to take actual reading of the alignment.



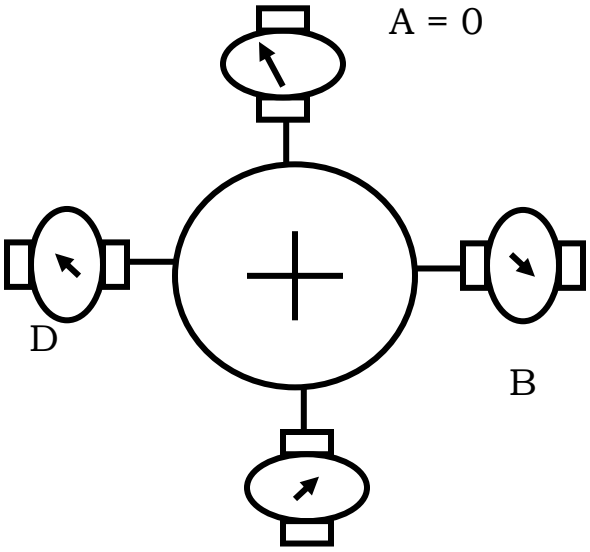
RADIAL



C = +0.015” (0.38 mm)

B + D = C

AXIAL



C = ± 0.008” ± 0.003”

B + D = C

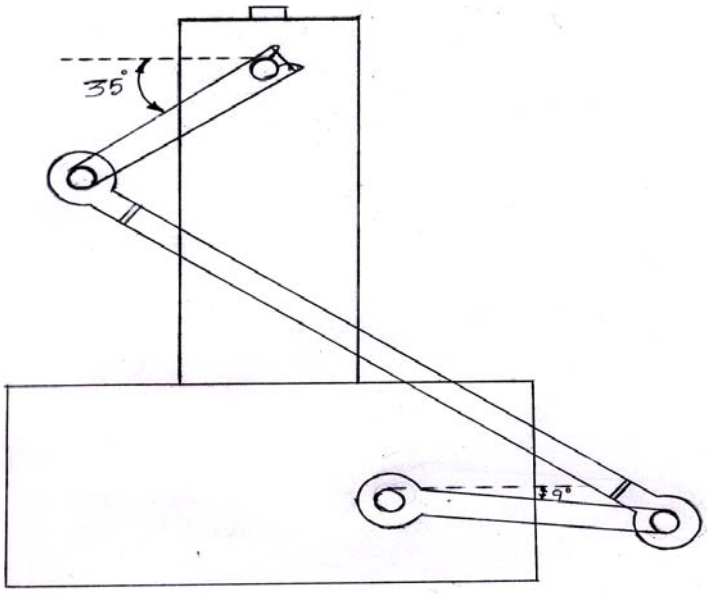
ACTUATOR SETTING:-

Model: EG-3P
Control system: 2301

FUNCTION OF ACTUATOR:-

- ✓ The actuator's terminal shaft (output) position is directly proportional to the input signal to the actuator (i.e. current).
- ✓ The main element of the actuator is an electro-hydraulic transformer which controls flow to and from the power piston through the action of a polarized solenoid.
- ✓ The piston of the actuator shaft is proportional to the input current to the solenoid coil controlling the hydraulic pilot valve plunger.
- ✓ The flow oil to and from the power piston is controlled by the pilot valve plunger.
- ✓ The actuator normally goes to minimum fuel position if the electric signal is stopped.

ACTUATOR



ELECTONIC CONTROL SYSTEM:-

- ✓ The output signal of the 2301 electric control is a level of voltage that determines the actuator terminal shaft position required to maintain a particular load on engine.
- ✓ The voltage is always same polarity.
- ✓ Electrical control must produce voltage at the lead terminals for actuator during cranking is equal to 4 Volts.
- ✓ Resistance between leads is 30 to 40 Ohms.
- ✓ Higher resistance is an indication of bad actuator.
- ✓ Coil current is 20 to 160 ma
- ✓ Coil resistance is 30 to 35 Ohms
- ✓ Actuator should have 50 ma at high idle.
- ✓ While staring the engine the actuator initially draw the current about 30 to 45ma.
- ✓ Actuator draws maximum current on load is upto160ma.

VISUAL INSPECTON

A) GOVERNOR LINKAGE CHECKS:

a. Linkage must move freely without binding and backlash.

b. Ensure full travel available to fuel off as well as fuel on positions.

c. Ensure joints are not in loose condition.

d. Ensure ball joints are pivot freely.

e. Oil pressure minimum at cranking speed 345psi at cold start (22 ^{o}C) and 115psi at hot start (85^{o}C).

f. Oil pressure at pressure tap (at rated speed) is 400psi.

B) MAGNETIC PICKUP

- ✓ The magnetic pickup to flywheel ring gear tooth clearance is 0.56 to 0.85mm.
- ✓ Tight the magnetic pickup to touch the flywheel and loose it by turning ½ round anticlockwise direction. This is approximately 0.56 to 0.85mm.

IMPORTANT POINTS TO REMEMBER:-

1. After cooler is responsible for cooling air.
2. Turbocharger boost pressure is measured at inlet manifold.
3. If the turbocharger compressor side seal fails there will be traces of oil in the air filter.
4. Turbocharger shaft end play specifications 0.004inch to 0.006inch
5. Oil cooler is responsible for cooling oil.
6. The temperature difference across outlet and inlet of the radiator is 7 to 11^{o}C
7. Pressurized cooling system is provided to increase the boiling temp of water.
8. The working pressure of D399 cooling system is 7psi.
9. Engine trips at a temperature setting of 99 ^{o}C.
10. Thermostat starts opening at 82 ^{o}C.
11. Thermostatic pilot valve is responsible for the tripping of the engine when there is overheating.
12. A fuel will detonate less if it has higher self ignition temperature.
13. An injection timing retard 5^{o} in a diesel engine will cause high boost.
14. Cetane number is determined by comparing the performance of diesel oil with the mixture of cetane and alpha methyl naphthalene.
15. Excess quantities of sulfur in diesel pave the way to formation of corrosive acids.

16. If one cylinder of a diesel engine receives more fuel than the others, then for that cylinder the exhaust temperature will be high.
17. If the intake air temperature of IC engine increases, its efficiency will decrease.
18. In a diesel engine combustion processes, the shift from controlled combustion to uncontrolled combustion happens due to rate of fuel injection.
19. Liner projection limits are given in the service manual. What would be the effect of an excessive liner projection? Liner flange crack.
20. Static injection timing in an engine is achieved by timing the FIP with the No1 cylinder TDC.
21. Which is not a test performed on an injector nozzle for deciding its serviceability. Valve opening pressure test, tip leakage test, injection pressure test√.
22. Normal operating fuel pressure in PSI --30 psi.
23. Glow plugs are provided for facilitating starting in cold temperature.
24. Nozzles of D399 are – Capsule type.
25. Transfer pump is mounted of the engine front right side.
26. In a D399 how many lifters are there in the fuel injection pump 16nos.
27. Bore & stroke of the engine is 6.25” X 8”.
28. D399 Engine has – number of camshafts—one.
29. D399 Engine has – Main bearings - 9nos.
30. D399 Engine has—number of connecting rods---16nos.
31. D399 Engine has – Thrust plates. 2nos (rear side).
32. Crankshaft Thrust plate in D399 Engine is positioned – rear.
33. Pistons of D399 Engine are made of alloy of Aluminium.
34. D399 Engine crankshafts can be ground –twice (25 thou + 25 thou).
35. D399 Engine has—Camshaft bushings 9nos.
36. Magnetic pickup is provided in flywheel housing.

37. Actuator Model on D399 Engine is EG3P.
38. D399 Engine pistons have—Piston Rings –3nos.
39. D399 Engine liner has--- O Rings and – Bands three and one respectively.
40. Air pressure required to start D399 Engine is 110psi
41. Each cylinder head has valves as 2 INLET AND 2 EXHAUST.
42. Speed of crankshaft with respect to the camshaft is TWICE.
43. Centre main journal of D399 engine has oil hole --true.
44. Rotation of Engine as viewed from flywheel is anti- clockwise—true.
45. Cooling system in D399 engine is pressurized –true.
46. Normal operating Oil pressure in PSI ---60.
47. Breather is located at ---Vee.
48. Crankcase explosion relief valve is located at inspection covers.
49. Pressure regulating valve is provided between the oil pump and oil cooler ---true.
50. Oil filter relief valve regulates oil-to-oil filters –true.
51. Pistons are lubricated by the oil from the-- cooling jets.
52. Rear gears get oil from the turbocharger drain---true.
53. Temperature difference across oil cooler is 7 ^{o}C.
54. Oil change interval has to be increased if the sulphur in the fuel is more—false.
55. What percentage of oil cooler cores can be blocked? if they are found to be leaking without affecting cooling system—7%.
56. When Engine is running at low idle speed what is the pressure at which low oil pressure shutdown takes place---20psi.
57. When an engine is running at rated speed. What is the pressure at which low oil pressure shutdown takes place---30PSI.
58. Oil in the Exhaust generally denotes turbocharger seal failure---true.

59. The purpose of keeping pre-combustion chamber is to burn low quality fuel.60.
61. The thermostat valve starts opening at 82^{o}C and full opening at 92 ^{o}C opening size 0.375".
62. Oil is required for cooling turbocharger from 578^{o}C engine exhaust temperature to 115 ^{o}C engine maximum operating temperature.
63. Inlet air must be cooled down to increase density so as to accommodate more oxygen molecules inside the cylinder for better combustion.
64. Factors that control combustion
    1. Volume of air compressed
    2. Type of fuel used
    3. Amount of fuel mixed with the air.
65. **CRANKSHAFT:-** Induction hardening of crankshaft is up to 150 thou (3.25 mm) from the outer surface. Two times under sizing is permissible (25 thou + 25thou). Minimum hardness is required for remaining service of the engine is 100 thou. The crankshaft is to be discarded beyond 50 thou undersize.
66. Change of RPM requires adjustment at two points:
    1. Rack setting
    2. Lifter setting
67. Oil change period depends on sulphur presence in the lub. Oil and load. TBN = 20 x sulphur presence in the fuel = 20 x 0.5 = 10. Oil should be changed if TBN comes down less than 50%. Sulphur content in the fuel + water = produce sulphuric acid which is Corrosive in nature.
68. High injection pressure to reach high fuel penetration.
69. Fuel dilution 4% is normal

70. **VALVE CUTTER*:***- There is a small gap between valve and valve seat during power stroke due to carbon deposit etc, the hot flame will pass through gap and seat will cut the portion of valve is called valve cutter.

71. **VALVE DROP:**- Valve drop occurs due to over speed of the engine/ due to the failure of lock(spit ring) that allow the valve to drop inside the cylinder cause damage to cylinder head, piston, liner, crankshaft and even cylinder block.

72. Increase in $1^{o}C$ of inlet air temperature will increase the temperature of $3^{o}C$

73. Backlash of accessory drive gear is 0.001inch (permissible)

74. Maxi. Blow by = 2" of H_2O when using H_2O manometer

75. Maxi. Blow by of New engine = 1cft/hr/rated hp of new engine

76. Exhaust temperature 540 ^{o}C.

77.

Injection + Mixing + Burning = Gives power

Power loss due to:

1. Delay in injection of fuel
2. Delay in mixing of fuel and air
3. Delay in burning of fuel

78. Total volume = Swept volume + clearance volume

$$\text{Compression ratio} = \frac{\text{Total volume (BDC)}}{\text{Compressed volume (TDC)}}$$

80. Valve opening pressure – 2500psi.

81. Nozzle injection pressure --- 15000psi.

82. Nozzle hole size – 5 micron.

83. Number of holes in a nozzle—7.

DO:-

- ✓ Daily physical checks are required before and after starting the engine to identify any abnormality that will help us to rectify the problem.
- ✓ Breather line is to be connected to outside canopy to avoid fumes enter into fins of radiator.
- ✓ Ensure all the safety systems are in working condition.
- ✓ Ensure the radiator cap is fitted and the cooling system is pressurized.
- ✓ Top up lubricant in engine oil sump preferably upto middle of dip stick.(in between low and high mark)

DON'T :-

- ✓ Do not operate the engine with safety system bypass.
- ✓ Don't operate the engine without radiator cap.
- ✓ Don't run the engine with abnormal smoke.
- ✓ Don't run the engine with overload.
- ✓ Don't run the engine with under load for long time.
- ✓ Don't run the engine with idle condition for more than 15minutes.
- ✓ Don't run the engine with overheating problem.
- ✓ Don't run the engine with mechanical noise.
- ✓ Don't run the engine with air cleaner element choking condition that lead to failure of turbocharger seal.

SPECIFICATION:-

Sl. No	Description	Model D379B	Model D398B	Model D399	Model 3508	Model 3512	Model 3516
01	Year of production	1961	1962	1967	1981	1981	1981
02	Bore in inch Bore in mm	6.25 158.8	6.25 158.8	6.25 158.8	6.7 170	6.7 170	6.7 170
03	Stroke in inch Stroke in mm	8 203.2	8 203.2	8 203.2	7.5 190	7.5 190	7.5 190
04	Cylinder arrangement	V- 8 60°	V- 12 60°	V – 16 60°	V- 8 60°	V – 12 60°	V – 16 60°
05	Engine type	Four stroke TA	Four stroke TA	Four stroke TA	Four stroke TA	Four stroke TA	Four stroke TA
06	Valve per cylinder	2	2	2	4	4	4
07	Displacement in cubic	1964	2945	3927	2105	3158	4210

	inches In liters	32.2	48.3	64.4	34.8	51.8	69.1
08	Compression ratio	15 : 1	15 : 1	15 : 1	13 : 1	13 : 1	13 : 1
09	Injection method	Pc/nozzle	Pc/noz-zle	Pc/noz-zle	Unit injector	Unit injector	Unit injector
10	Type of governing	Electron-ic	Electro-nic	Electro-nic	Electron-ic	Electron-ic	Electro-nic
11	Power	610hp	912hp	1215h-p	860hp	1321hp	1576h-p
12	Speed	1200 rpm	1200 rpm	1200 rpm	1200 rpm	1200 rpm	1200 rpm
13	Cetane number	35	35	35	40	40	40
14	Tappet clearance	Inlet 0.015" Exhaust 0.035"	Inlet 0.015" Exhaust 0.035"	Inlet 0.015" Exhaust 0.035"	Inlet 0.020" Exhaust 0.040"	Inlet 0.020" Exhaust 0.040"	Inlet 0.020" Exhaust 0.040"
15	Crank shaft end play					0.13 to 0.89mm	

T- Turbocharged TA – Turbocharged after cooled

STA – Series turbocharged after cooled

PARAMETERS:-

Sl.no.	Parameters	D379	D398	D399
01	Air pressure for starter	100 to 150psi	100 to 150psi	100 to 150psi
02	Jacket water temp (normal range).	75 to 90°C	75 to 90°C	75 to 90°C
03	Maxi. Oil temp.	110 °C	110 °C	110 °C
04	Maxi. Inlet air temp.	115 °C	115 °C	115 °C
05	Maxi. Exhaust temp.	540 °C	540 °C	540 °C
06	Engine oil pressure	45 to 70psi Most apropriate59 to 66	45 to 70psi Most apropriate56 to 63	45 to 70psi Most apropriate56 to 63
07	Fuel pressure	20 to30PSI	20 to30PSI	20 to30PSI
08	Allowable pressure difference across oil filter	12 to 15psi	12 to 15psi	12 to 15psi
09	Minimum jacket water temp. for starting engine	32 °C.	32 °C.	32 °C.
10	Clearance between magnetic pickup and flywheel	0.022 To 0.030 inch	0.022 To 0.030 inch	0.022 To 0.030 inch

NOTE:

- Thermostat valve starts open at 82 ^{o}C
- Thermostat valve completely open 92 ^{o}C
- Thermostatic pilot valve in the HMSO circuit opens at 99 ^{o}C and shutoff the engine.

OIL PAN CAPACITY IN LITERS:-

Sl.no	Capacity	D379	D398	D399
01	Engine crank case in lts	189	246	416
02	Engine coolant including radiator	257	422	530
03	Low idle rpm	600	600	600
04	Valve lash Inlet Exhaust	0.015inch 0.035inch	0.015inch 0.035inch	0.015inch 0.035inch

METALLURGY OF ENGINE COMPONENTS:-

Sl.no.	Description	D398	D399
01	Flywheel	Cast iron	Cast iron
02	Flywheel housing	Cast iron	Cast iron
03	Crank shaft	Forged steel	Forged steel
04	Main bearing (Crank shaft)	Steel-backed Al-alloy	Steel-backed Al-alloy
05	Connecting rod bearing	Cast bronze	Cast bronze
06	Crank pin bearing	Steel-backed Al-alloy	Steel-backed Al-alloy

07	Wrist pin bearing	Hardened steel alloy	Hardened steel alloy
08	Bushing	Steel-backed bronze	Steel-backed bronze
09	Piston	Cu-Si-Al Alloy casting	Cu-Si-Al Alloy casting
10	Piston ring compression	Cr-Carbide(top) & Chrome plated Ni-Resistance	Cr-Carbide(top) & Chrome plated Ni-Resistance
11	Piston ring oil	Chrome plated	Chrome plated
12	Cam shaft	Forged Steel	Forged Steel
13	Bearing (Cam shaft)	Steel – Backed Al alloy	Steel – Backed Al alloy
14	Cylinder Block	Cast alloyed Gray iron	Cast alloyed Gray iron
15	Cylinder Liners-type	Wet Cu-Cr-Mo Cast iron alloy, hardened	Wet Cu-Cr-Mo Cast iron alloy, harden
16	Oil pan	Al-Casting or welded Steel	Al-Casting or welded Steel
17	Cylinder head	Cast alloyed Gray iron	Cast alloyed Gray iron
18	Exhaust valve-stem	Steel	Steel
19	Exhaust valve-head	Cr-Ni-Mo alloy	Cr-Ni-Mo alloy
20	Seat insert	Ni-Alloy Casting	Ni-Alloy Casting
21	Intake valve -stem	Steel	Steel
22	Intake valve-head	Cr-Ni-Mo alloy	Cr-Ni-Mo alloy

2. PNEUMATIC SYSTEMS (COMPRESSED AIR):-

Fluid power system using air as medium for developing, transmitting, controlling and utilizing power is **called pneumatic system.**

Compressed air is an important energy source for controlling and operating the Drilling Rig Equipment. The compressed air an energy transfer medium connects the operator with mechanical equipment for better control and faster operation. Air prosperities mainly influence the controlling systems. The compressed air must be properly treated before sending into pneumatic components/systems. Air as a source of energy is more flexible to use at a time for different applications in the Rigs. It is capable of taking over a large number of functions in the Rig. Pneumatic system as compared to other power sources is low cost to produce, easy to handle, easy to maintenance, and better for safety. It liberates man from repetitive manual activities in the derrick floor. With introduction of pneumatic system in the rig, the operators activities are Integrated and synchronized with various equipment by standing at one place. Pneumatic system is more effective medium for continuous operation over a long period at a faster rate.

ADVANTAGE OF AIR OVER HYDRAULIC FLUID:-

- Available in plenty
- Compressible
- Easily storable
- Transportable
- Insensitive to temperature
- No risk of explosion and fire- hence it is safe
- Clean and non pollutant
- Fast expandable

- Suitable for high speed operation
- Learnable technology
- Easy to operate
- Low cost energy

Why dry and clean compressed air is necessary for pneumatic system?

Atmospheric air contains:-

- Nitrogen
- Oxygen
- Carbon dioxide
- Water vapor
- Other gases like neon
- Dust
- Smoke

Compressed air should be free from all contaminant for better and efficient operation of pneumatic system and its component. It also helps the component for longer life.

NOTE: Compressor having the capacity of 3 m^3/min at 7.5 bar produces 40 liters of water per day.

Problems in pneumatic system due to contamination of air:-

- Corrosion
- Pressure losses
- Increase the tool wear
- Faults in pneumatic controls
- Delay in response time
- Expensive down time

Dry air is absolute necessary for proper functions of pneumatic systems.

DRY AND CLEAN AIR:-

Free from all contaminants and having

- 78% of nitrogen molecules
- 21% of oxygen molecules and
- 01% of other gases

What is compressed air? How achieve it?

Pressurized atmospheric air is called compressed air. Compressor is converting mechanical energy into gas energy by means of compressing air at desired working pressure.

Why compressed air is needed?

Compressed air is needed to carry energy for work at different locations/ areas/equipment.

GENERAL APPLICATION OF PNEUMATIC SYSTEM:-

- Power application
- Process application
- Control application

APPLICATION IN RIG:-

- **Power application**

Ex: starting of engine, engaging clutches

- **Control application**

Ex: driller's console

TYPE OF VALVES:-

1. Directional control valve
2. Non-return valve

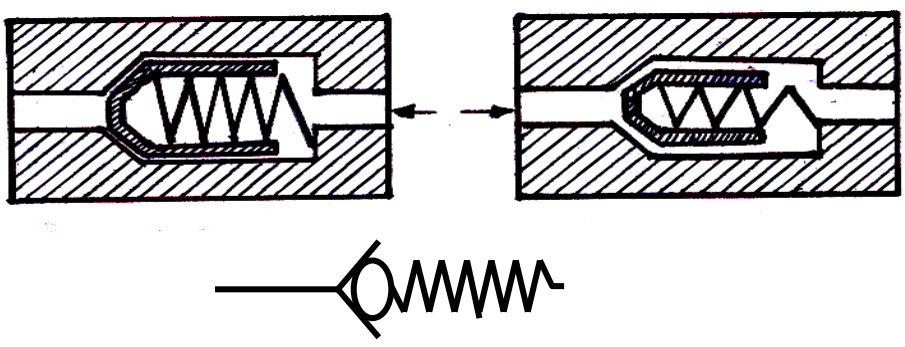
3. Pressure control valve
4. Flow control valve
5. shut-off valve

The various types of valves are used in the pneumatic system to control, regulate and direct the flow of compressed air according to operational requirement.

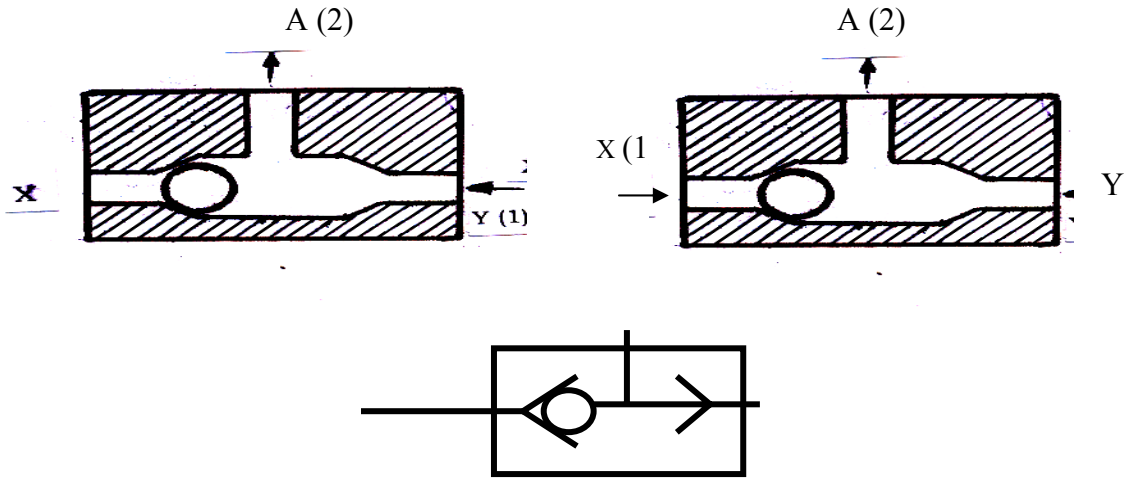
VARIOUS TYPES OF PNEUMATIC VALVES AND THEIR FUNCTIONS:-

Sl.no.	Description	Functions
01	Directional control valve	On/off function
02	Over ride valve	Cracking pressure
03	Relief valve	Limiting pressure
04	Pressure reducing valve	Reducing pressure
05	Flow control valve	Regulate flow
06	Check valve	Permits flow of air in one direction
07	Shuttle valve	Permits flow of air in two direction
08	Normally open (solenoid valve)	Normally open position
09	Normally closed (solenoid valve)	Normally closed position

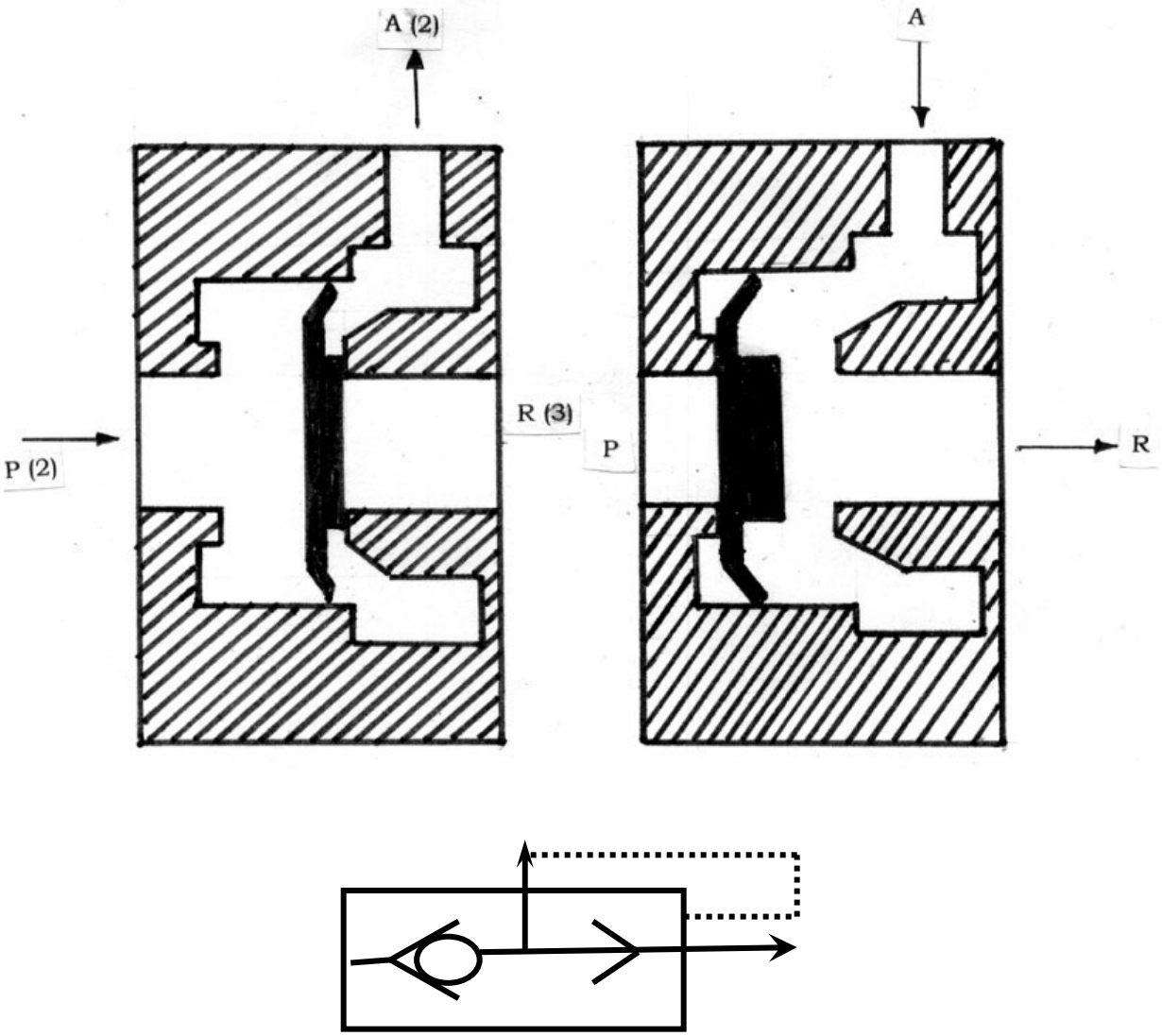
CHECK VALVE



SHUTTLE VALVE

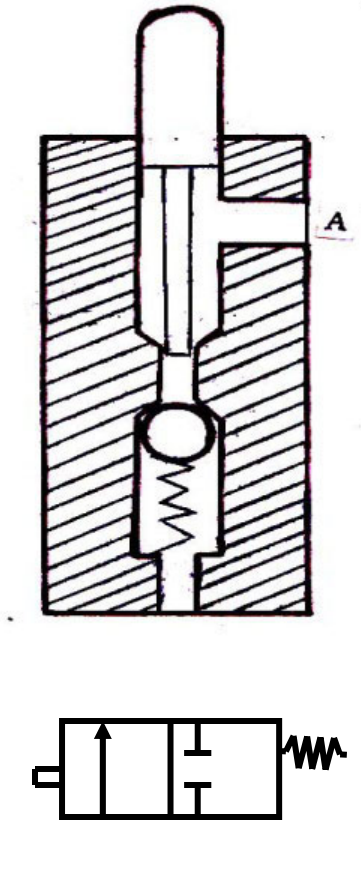


QUICK RELEASE VALVE

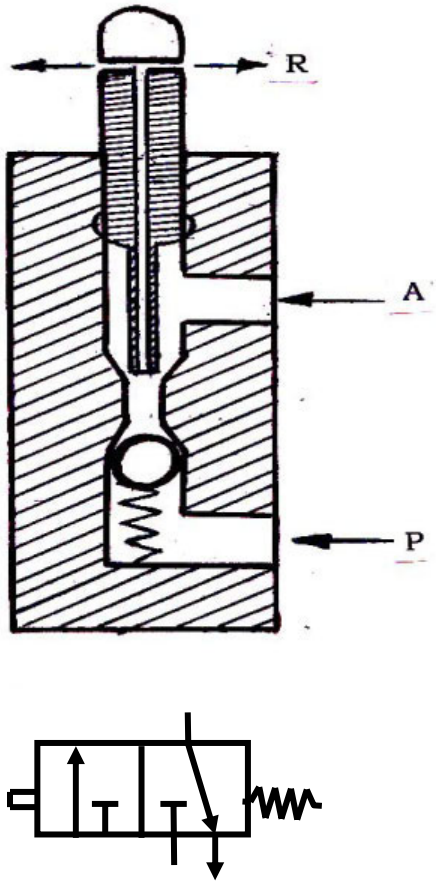


DIRECTIONAL CONTROL VALVE

2 / 2 WAY



3 / 2 WAY

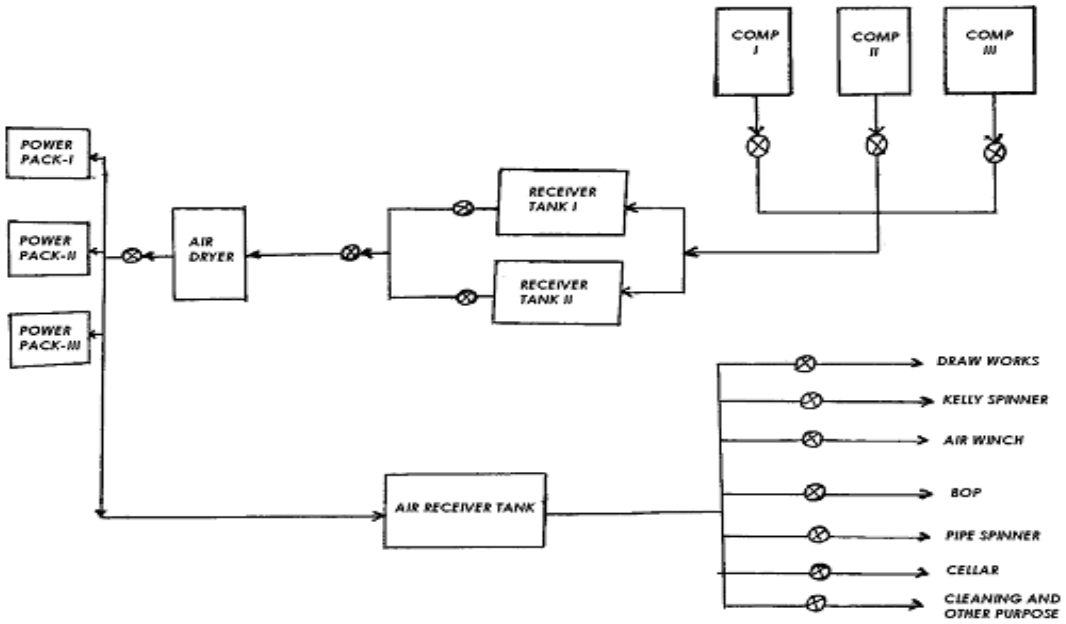


APPLICATION OF COMPRESSED AIR IN DRILLING RIG EQUIPMENT:-

- Main power pack engines
- Draw works
- Rotary table
- Air winch
- BOP
- Kelly spinner
- Pipe spinner
- Purging of electrical panel in driller's console

- Cellar pit cleaning
- Air horn
- Cleaning of casing pipe and drill pipe

AIR FLOW DIAGRAM OF DRILLING RIG:-



TYPES OF COMPRESSORS:-

POSITIVE DISPLACEMENT

- Screw compressor
- Reciprocating compressor

DYNAMIC TYPE

- Centrifugal compressor

COMPRESSOR:-

Drilling Rigs are equipped with two types of compressors for utility service in drilling operations of Cauvery Asset. They are M/S ELGI make screw and reciprocating compressors and M/S khosla make screw compressors.

ELGI SCREW COMPRESSOR:-

Model:

- SR12100LH
- SR12---12series
- 100----HP of motor
- LH---- low and high pressure application
- Free air delivery------250CFM(7.08M^3/MIN)
- Working pressure-------10.5kg/cm^2(150psi)
- Receiver sump capacity----100ltrs
- Oil fill capacity ----------24ltrs
- Normal operating temperature-----80^oC
- Temperature switch shutdown at 116 ^oC

Pump dealing with air vapours and gases are called Blowers in small sizes and Compressors in bigger sizes.

WORKING PRINCIPLE OF SCREW COMPRESSOR:-

The screw compressor is a positive displacement type. It has two rotors housed in a cast iron casing called "stator". One of the rotors is called 'male rotor' and other one is called 'female rotor'. The male rotor has four asymmetrical lobes (piston) that run helically along the rotor length and female rotor too has six similar helical flutes (cylinder). These two rotors rotate in conjunction with each other inside the casing. Drive is usually provided to male rotor, through a set of gears.

Air is admitted at one end of the rotors where the matching lobe and flute first come into mesh as the rotors turn. Continued rotation brings the line of mesh past the air-inlet port and then the air in the flute of the female rotor is confined by the lobe of the male rotor and stator

housing. Compression now occurs as the rotors turn further. At that time, the far end of the compression pocket turns towards the discharge port and air flows out in the system. Lubricating oil is injected into the compressor in large quantities mixes directly with the air as the rotors turn compressing the air.

BASIC FUNCTION OF LUBRICATING OIL:-

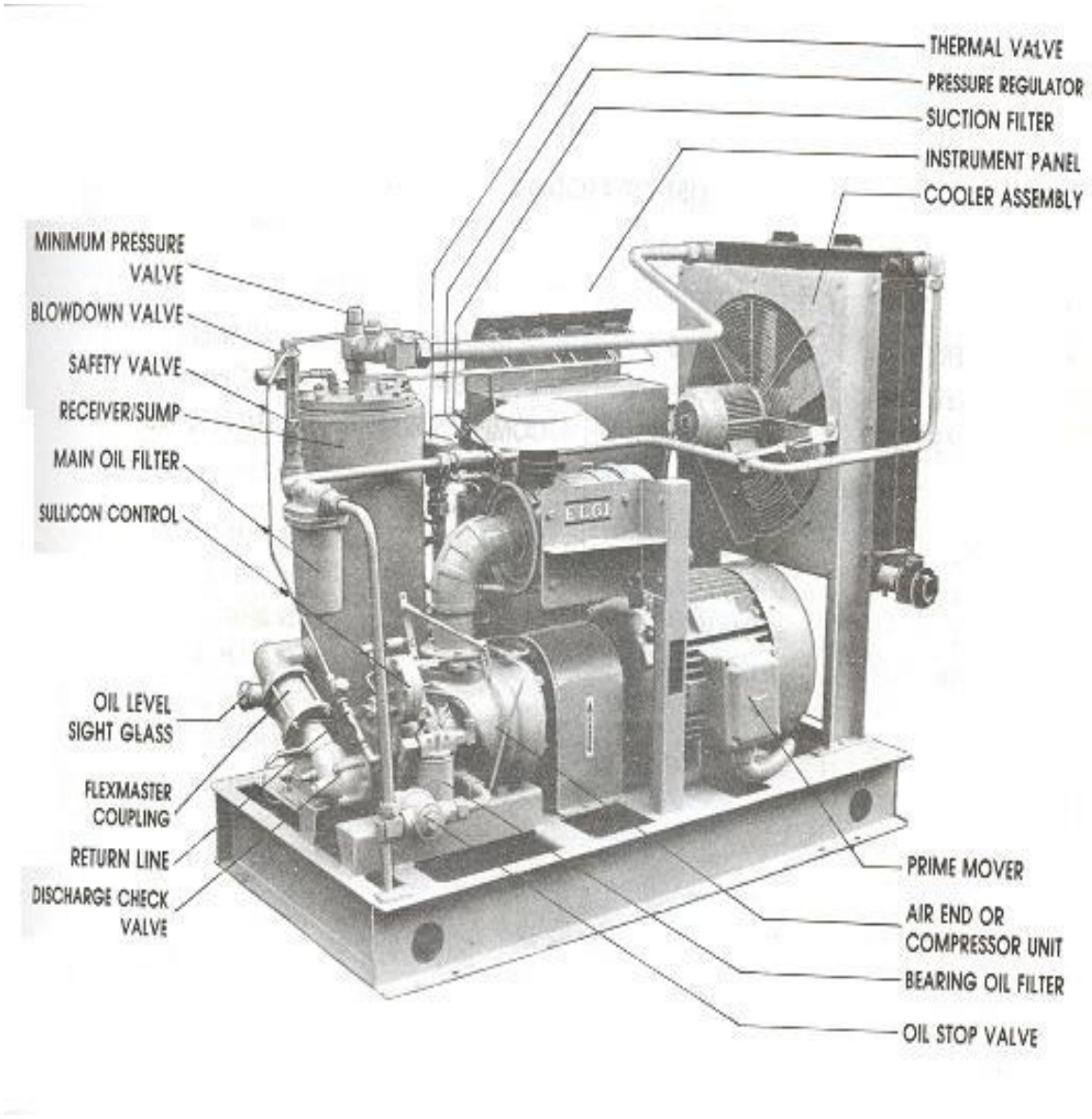
1. As a coolant it takes away the heat of compression.
2. Seals the leakage paths amongst the rotors and housing.
3. Acts as a lubricating film between the rotors allowing one rotor to directly drive the other without a metal to metal contact.
4. Lubricates the bearings and gears.

PRINCIPLE OF OPERATION:-

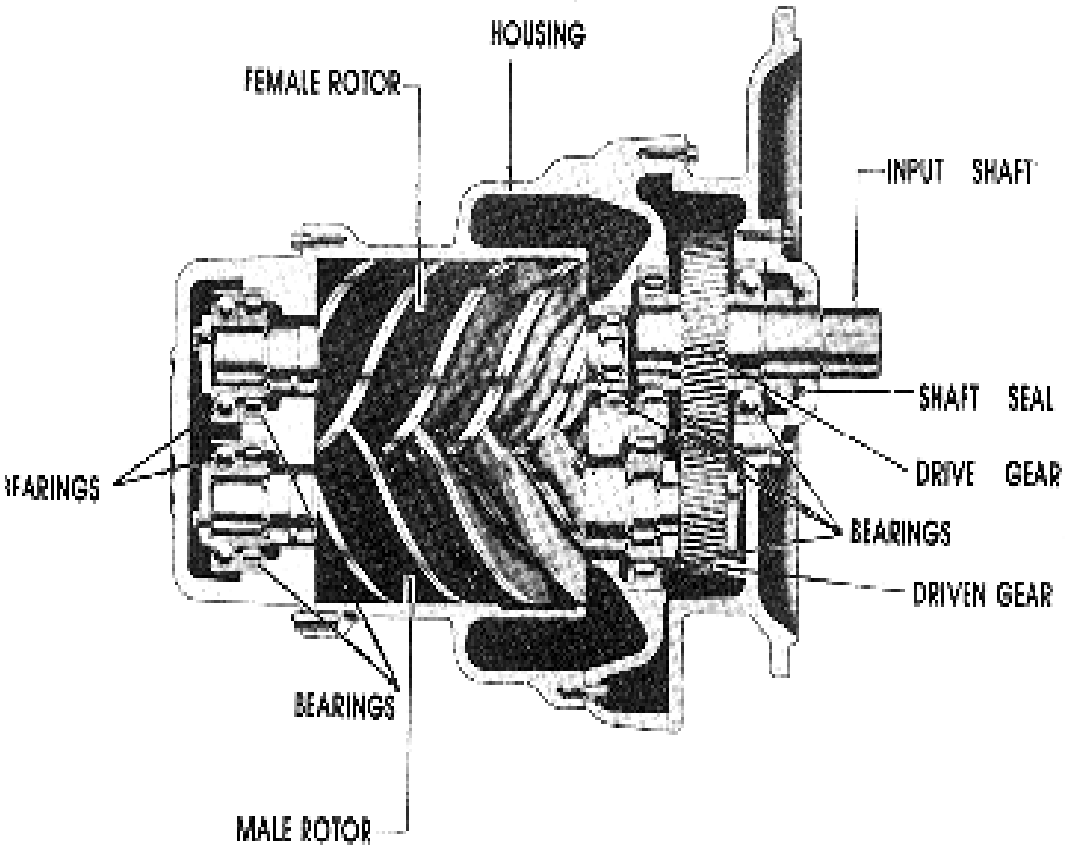
The air aspirated through the air filter is compressed in the screw compressor driven by an electric motor. The injected oil removes the compression heat generated. This internal cooling makes possible very low compression end temperatures. Under normal conditions the compression end temperature amounts to approx. $80^{o}C$. Oil and air are separated by the in-line 3-stage oil separator. The separated oil is cooled in the oil cooler and is returned to the injection point via. the micro filter. This oil circulation circuit operated solely by the pressure differential does not require any oil pump. The compressed air liberated from oil in the oil separating cartridge, except for a very small amount of residual oil, is passed to the air after cooler via the minimum pressure non-return valve.

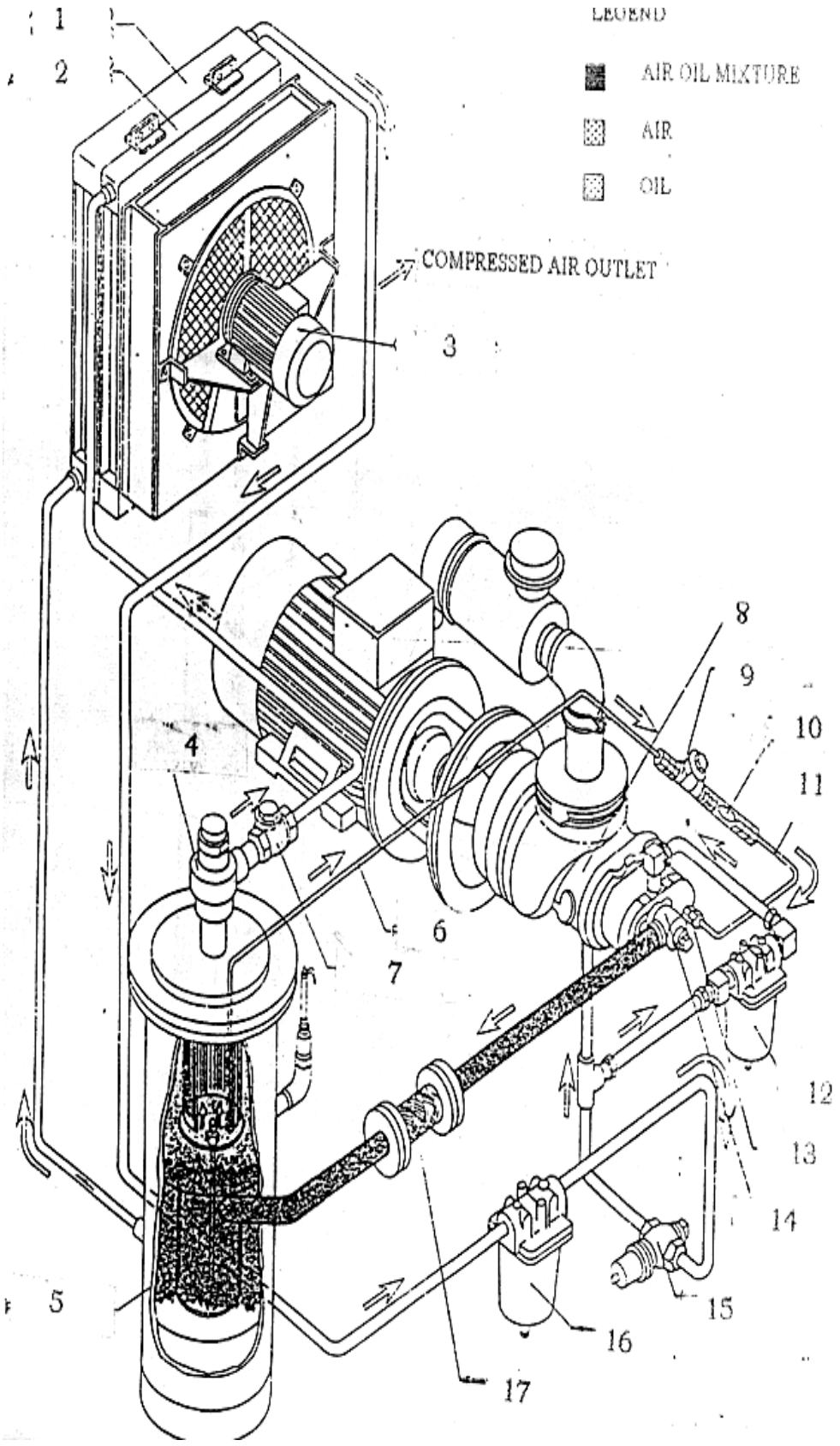
The combined minimum pressure/non-return valve downstream of the oil separator maintains a minimum pressure for safe supply of oil to the compressor. The temperature of the compressed air at the unit

discharge side is lowered to within a few degrees above ambient temperature by the air after cooler which is fitted as a standard.



SCREW COMPRESSOR




LEGEND
AIR OIL MIXTURE
AIR
OIL
COMPRESSED AIR OUTLET
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17

COOLING AND LUBRICATION SYSTEM – AIR COOLED VERSION

1	Air Cooled Oil Cooler	10	Return Line Oil Sight Glass
2	Air Cooled After Cooler	11	Return Line
3	Cooling Fan Motor	12	Bearing Oil Filter
4	Minimum Pressure Valve	13	Orifice
5	Receiver Tank	14	Discharge Check Valve
6	Terminal Check Valve	15	Oil Stop Valve
7	Terminal Check Valve	16	Main Oil Filter
8	Air End	17	Flexible Hose
9	Return Oil Strainer		

Screw compressor has the following components and systems:-

1. Air end(compressor unit)
2. Air inlet system
3. Air discharge system
4. Cooling and lubrication system
5. Control system
6. Electrical system
7. Safety system
8. Instrument panel.

AIR INLET SYSTEM:-

It consists of a dry-type air filter, a restriction gauge and an air inlet valve. The butterfly type air inlet valve directly controls the amount of air-intake into the air-end in response to the operation of the silicon control.

DISCHARGE SYSTEM:-

The compressor discharges the compressed air-oil mixture through a discharge check valve into the combination receiver-sump. The

discharge check valve prevents air in the receiver from returning to the compression chamber after the machine has been shut down.

RECEIVER SUMP:-

It has got three main functions

1. Acts as the primary oil separator
2. Serves as the compressor oil sump
3. Houses for oil separator element

Oil collected at the bottom of the separator is return to the compressor by a pressure difference between the separator and the compressor inlet. The pressure drop across the separator element shows more than 15psi the separator element needs replacement.

MINIMUM PRESSURE VALVE:-

A minimum pressure valve is located at the downstream of the separator (just above the sump) assures a minimum receiver pressure of 3-4kg/cm^2 during all conditions. This pressure is necessary for proper air-oil separation and to assure proper oil circulation in the system.

CHECK VALVE:-

It is located after minimum pressure valve to prevent compressed air in the service line from bleeding back into the receiver on shutdown and during operation of the compressor in an unload condition.

PRESSURE RELIEF VALVE:-

It is located at the wet side of the separator. It will release sump pressure if the sump pressure exceeds 2.5kg/cm^2 more than that of compressor working pressure.

HIGHER PRESSURE SHUTDOWN SWITCH:-

The purpose of compressor is to shutdown the compressor at 2kg/cm^2 more than that of working pressure. It prevents the pressure relief valve from opening under routine conditions, thereby preventing oil loss through the pressure relief valve. A temperature switch will also shutdown the compressor if the discharge temperature reaches116^oC.

BLOW-DOWN PRESSURE SWITCH:-

It senses service line pressure when the line pressure reaches a pre-set valve pressure switch signals the solenoid valve to unload the machine.

BLOW-DOWN VALVE:-

Blow-down valve vents sump pressure to the atmosphere during unloading and shut off.

SILICON CONTROL:-

Regulates the amount of air required to the compressor through air intake manifold of the air-end. This regulation is determined by the amount of air being used in the service line.

THERMAL VALVE:-

It regulates the temperature of oil getting into the air-end by by-passing the same to oil-cooler in case the temperature of oil exceeds preset value.

COMPRESSOR COOLING & LUBRICATION SYSTEM:-

Oil flows from the bottom of the receiver/sump to the thermal valve. The thermal valve is fully open when the oil temperature is below preset temperature. The oil passes through the thermal valve, main filter,

bearing filter and to the compressor unit where it lubricates, seals and cools the rotors and the compression chamber.

As the discharge temperature rises above preset temperature due to heat of compression the thermal valve begins to close and a portion of the oil then flows to the cooler for cooling. From the cooler the oil passes to compressor unit through filters.

NOTE: The pressure in the receiver/sump causes flow of oil from the high pressure area in the sump to an area of lower pressure in the compressor unit.

BEARING FILTER:-

It has a replacement element and an integral pressure by-pass valve. When the pressure drop exceeds 5 kg/cm^2 the filter needs servicing.

OIL STOP VALVE:-

The oil stop valve prevents oil flow to compressor when the compressor is shut off. When the compressor is operating, the oil stop valve is held open by the pilot pulse from the air end allowing a free flow of oil from the receiver/sump to the air end. On shut-of, the air end pressure gets reduced significantly causing the oil stop valve to close and cut off oil supply to air end.

IMPORTANT POINTS TO REMEMBER:-

- ✓ If lub. oil is coming out from the suction air filter of the compressor while stopping the compressor, then it is the failure of oil stop valve change it.

- ✓ Overheating of compressor may be due to insufficient oil in the sump (or) oil cooler choke (or) cooling motor fan failure (or) thermostat valve failure etc; check the causes and rectify problem.
- ✓ If differential pressure in the oil separator exceeds15psi, then change the element.
- ✓ Compressor should run in the right direction as per arrow mark in the air end.
- ✓ Frequent loading and unloading of compressor is due to air cooler puncture or blow down valve malfunction or line leakage or more consumption of air. Causes to be checked and rectify the problem.

DO:-

- ✓ Top up oil up to mark.
- ✓ Ensure safety systems are in place.
- ✓ Check the direction of rotation as per arrow mark.

DON'T :-

- ✓ Don't allow to run the compressor with reverse rotation. The compressor may cease immediately.
- ✓ Don't allow to run the compressor with overheating problem.
- ✓ Don't allow to run the compressor with excess differential pressure of oil.

II. HOISTING SYSTEM OF RIG E-760

1. DRAW WORKS

Model:	- E760
Draw works capacity	- 1000 hp
Motor capacity	- 750 kw/1000 hp
Motor speed	- 1000 rpm
Draw works speed -ratio	- 21.3:1

The draw works is powered with two DC motors of 1000 hp each. Either of these motor can be put into operation at a time. The additional motor is only for standby operation. Draw works is the heart of the drilling operation without which no work can be performed on the derrick floor. It requires more care and maintenance due to involvement of different mechanisms, rugged use, severity and frequency of operation. More over it doesn't have any standby.

Draw works consists of

a. Driller's console
b. Prime mover.
c. Transmission system.
d. Hoisting system.
e. Brake system.
f. Lubrication system.
g. Cooling system.
h. Pneumatic control system.

a) Driller's console:-

Driller's console is an integral part of draw works. It consists of electrical and pneumatic circuits and valves. The main functions of driller's console are to integrate all electrical and pneumatic circuit in a single platform and facilitate the driller to operate and control varies activities of drilling operation by standing in a convenient place without much difficulties.

b). PRIME MOVER

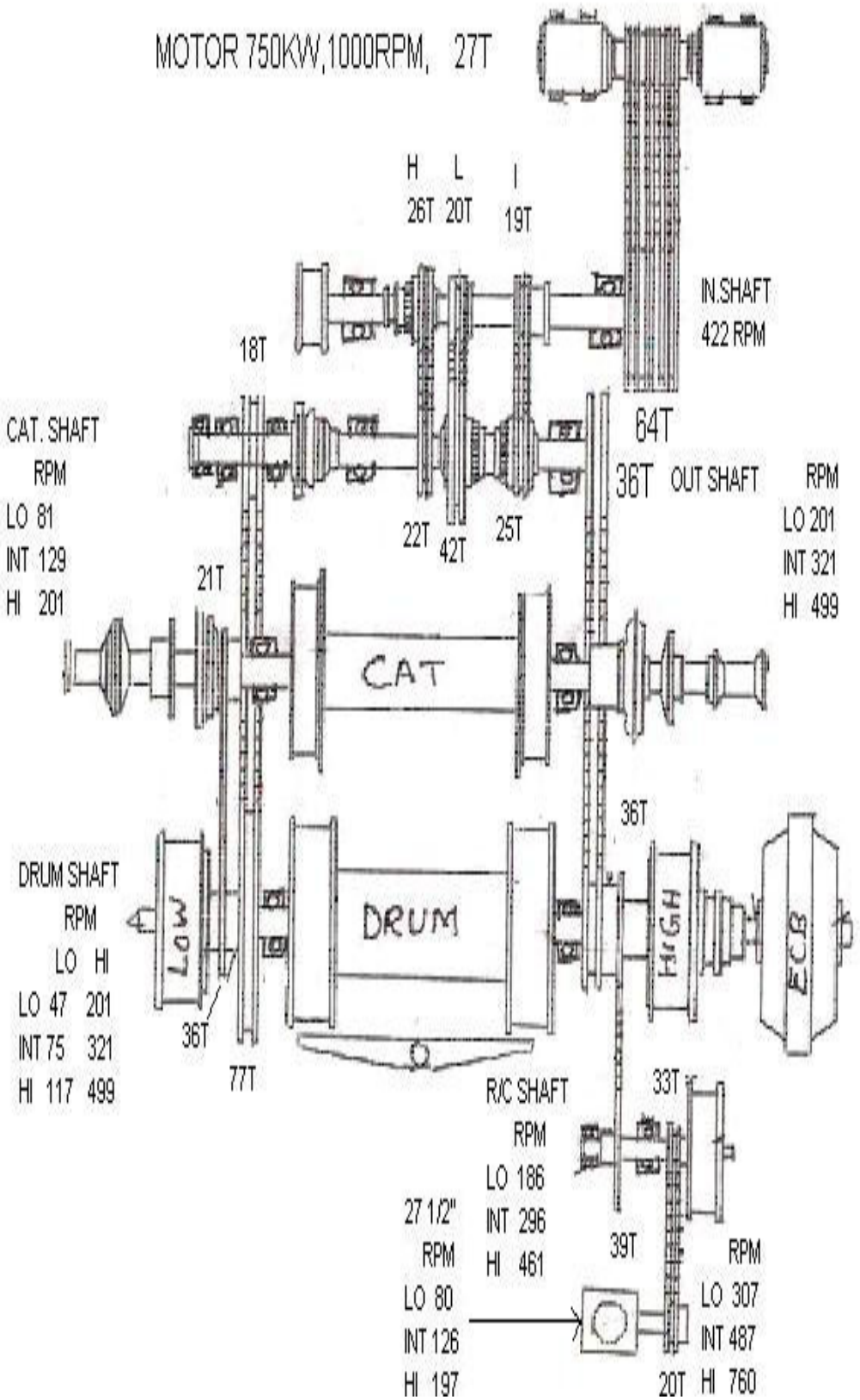
DC motors:

- Are prime movers of Draw works
- Convert electrical energy input to mechanical energy
- Provide mechanical energy input to the draw works.
- Suitable to variable speed requirement of draw works.

C.TRANSMISSION SYSTEM:-

The transmission system consists of motor, input shaft drive, output shaft drive, low clutch drive and high clutch drive, rotary counter shaft drive and sand reel shaft drive etc. The purpose of transmission system is to provide variable speed and torque to main drum, cathead and rotary according to their speed and load requirement. Particularly the combination of a set of sprockets of the input and output shafts with low or high clutches provide a variable torque and speed to main drum shaft for proper function. The power flow diagram along with speeds calculations are illustrated in this chapter to understand about draw works transmission system in a better way. This will help the operator to select the suitable transmission for lifting load and maintenance crew to diagnoses the problem in a systematic way.

TRANSMISSION SYSTEM



SPEED CALCULATION:-

I. Input shaft speed (27/64X1000rpm) = 422 rpm

II. Output shaft speed - 201 rpm, 321 rpm, 499 rpm

OUTPUT SHAFT RPM (at 1000 RPM of Motor)

Low Transmission	20/42 X 422=201rpm
Intermediate	19/25 X 422=321rpm
High Transmission	26/22 X 422=499rpm

III. Low clutch speeds – 47 rpm 75 rpm, 117 rpm

IV. High clutch speeds-- 201 rpm, 321 rpm, 499 rpm

DRUM SPEED

Transmission	Low clutch	High clutch
Low	18/77 X 201=47 rpm	36/36 X 201=201 rpm
Intermediate	18/77 X 321=75 rpm	36/36 X 321=321 rpm
High	18/77 X 499=117 rpm	36/36 X 499=499 rpm

HOOK LOAD CAPACITY

Drum clutch	Transmission clutch	Speed	10 lines in lbs	10 lines in tonnes
Low	Low	47	4,18,000	190
	Intermediate	75	3,35,000	152
	High	117	2,99,000	136
High	Low	201	2,12,000	96
	Intermediate	321	1,30,000	54
	High	499	83,500	37

V. Rotary counter shaft speeds 186 rpm, 296 rpm, and 461 rpm

Output shaft rpm = High clutch rpm

ROTARY COUNTER SHAFT RPM

Output shaft	R/c	Rpm
Low	36/39 X 201	186
Intermediate	36/39 X 321	296
High	36/39 X 499	461

VI. Rotary input rpm: 307, 488, 760

ROTARY INPUT RPM

R/c shaft	Rotary input	Rpm
Low	33/20 X 186	307
Intermediate	33/20 X 296	488
High	33/20 X 461	760

VII. Rotary turntable rpm: 80, 126, 197

ROTARY RPM

Rotary pinion	Turntable	Rpm
Low	20/77 X 307	80
Intermediate	20/77 X 487	126
High	20/77 X 760	197

Sand reel drum:-

- Used for hoisting & lowering of tool required for directional drilling.

Sand reel shaft:-

- Giving power to sand reel drum, spinning and break out catheads.
    - Capacity = 16000 lts
    - Wire line = 9/16”
    - Clutch = 24 CB 500

Catheads:-

- Spinning / makeup cathead is used for tightening drill pipes.
- Break out cathead is used for breaking drill pipes.

CATHEAD RPM

Low clutch	Cat head	Rpm
Low	36/21X47	81
Intermediate	36/21 X 75	129
High	36/21 X 117	201

AIRFLEX CLUTCHES

Sl. no.	Rig E760 equip.	Desc.	Clutch drum size (dia. x width)	Maximum allowable wear on drum dia.	Minimum allowable drum dia.	Minimum allowable lining thickness
01	Draw works low & high clutches	32 VC 1000	32"x 10"	3/16"	32"-3/16" = 31 x 13 /16"	3/8"
02	Rotary & Sand reel clutches	24 CB 500	24" x 5"			

EXAMPLE:

- 32VC1000 – Original drum diameter = 32.00 inches. Minimum allowable drum dia. is 32.00-3/16 = 31 13 /16.
- 38VC 1200 – Original drum diameter = 38.00 inches. Minimum allowable drum dia. is 38.00-3/16 = 37 13/16.

Air flex CB and VC clutches are simple in design and construction, rugged, self-adjusting, shock absorbing and do not require any lubrication. The torque arm is the drum radius not a reduced radius as in plate clutches. The tube under the influence of compressed air expands about 0.12"(3mm). The tube distributes the clamping pressure evenly

around the full circle and across the entire drum width. This is an efficient method of transmitting torque.

Centrifugal force acting on the friction shoes when the clutch is rotating, forces the friction shoes off the drum surface quickly. Centrifugal force also helps to force air from the tube. As friction surfaces wear, the tube expands further and compensates for the wear. Normal friction surface wear will not reduce the torque capacity. The tube is constructed to work within the normal wear limits without requiring additional air pressure to achieve full clutch torque. The dampening quality of neoprene is constantly reducing the effects of torsional vibration. The tube is also able to flex sufficiently to operate misaligned, parallel or angularly. Air is an easy medium to control. Flow rates and pressures are variable within wide ranges.

The air flex CB clutch torque capacity is directly proportional to the air pressure applied up to the maximum air pressure permissible. Permissible misalignment is indirectly proportional to the air pressure. The VC clutch is suitable for applications at higher air pressures than the CB model. Within the design limits, the clutch will transmit full torque at the same air pressure regardless of the amount of wear. Air expands the actuating tube uniformly engaging the 360^{o} friction surface at maximum diameter to provide greatest operating torque.

The actuating air tube automatically compensates for friction shoe wear, eliminating the need for adjustment centrifugal force and release springs assure total disengagement of the friction shoes from the drum the moment the air is expelled. Lubrication is not required. The torque developed is proportional to the applied air pressure. By limiting the applied pressure, the element will act as a torque-limiting device and provide overload protection. To accomplish regulated or cushioned engagement of the element, a flow control valve is installed with restricted flow to element and free flow away from element. When the

friction material has worn down approximately two thirds of its original thickness, friction linings must be replaced in complete sets not few at a time. The number preceding letters VC in the element size designates the original drum diameter in inches.

d). HOISTING SYSTEM

The E760 Draw works is equipped with an engineered drum 25" in diameter by 49¾" long. The drum is provided with Lebus grooving system for reeving the wire rope. This draw works is engineered to fully load the capacity of 1¼" wire line, and when using this size line it will provide for 8 lines reeving with no more than three layer spooling on the drum.

Drum

- Drum size – dia by length --- 25" X 49 ¾"
- Drum brake – dia by width ---- 46" X10"
- Number of speed --- Drum Forward ------ 6
- Rotary Forward ------3
- Lebus groove are for spooling of 1 ¼" wire line.
- Accommodates 8 line reeving and- three layers spooling on the drum.

e). DRAW WORKS BRAKE SYSTEM:

Large diameter drum barrel with 10" x 46" water circulating type brake rims bolted to drum. Full wrap single point adjusted, fully equalized brake bands to deliver extra self-energizing effort.

BRAKE:-

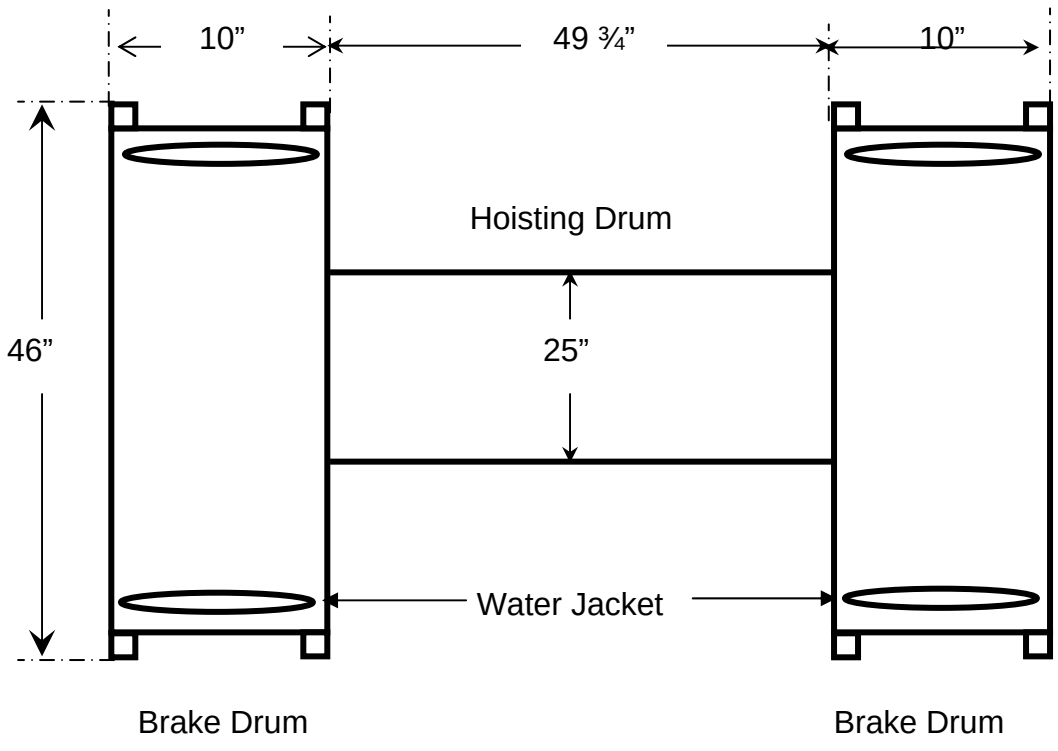
It is a device by means of which artificial frictional resistance is applied to a moving/rotating body in order to retard (or) stops the motion of a body.

Exterior band type brakes, which consists of

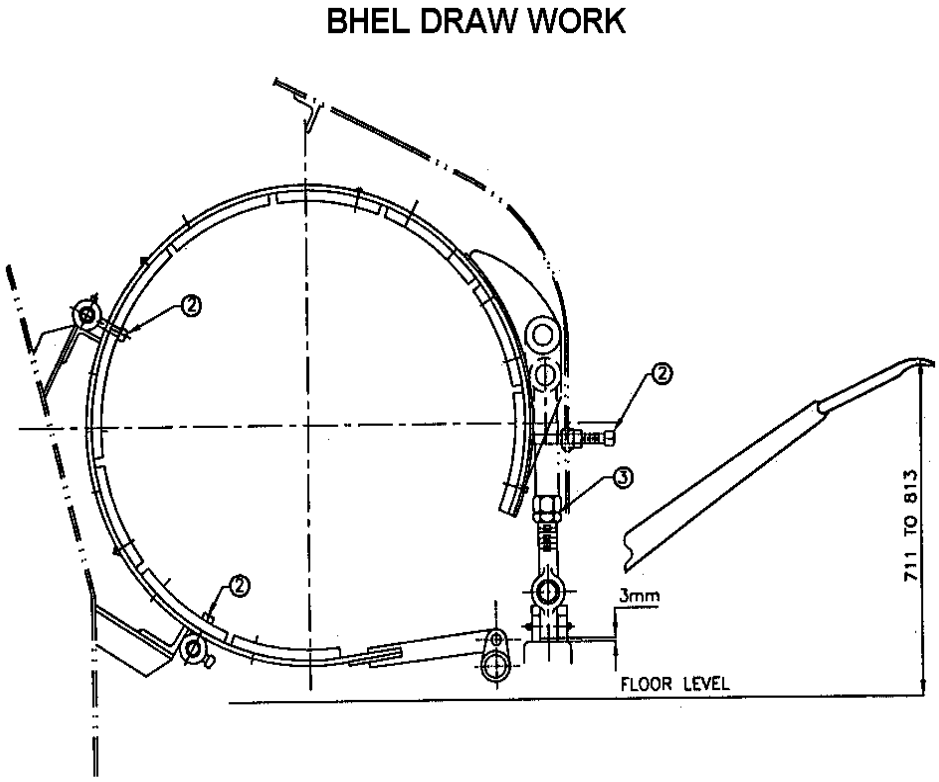
- Hoisting drum
- A pair of brakes
- Brake blocks
- Lever mechanisms.

Hoisting drum:-

- With steel brake rims at each end.
- It will be slowed / stopped when the brakes are applied.
- The rims of hoisting drum provide the braking surface for the brake blocks.
- Brake flanges are water cooled through a stuffing box.



BRAKE BAND:-



DRAW WORKS BRAKE ADJUSTMENT:-

A. Using special wrench attached to inside of front guard adjust nuts (1) on dead end of each band until brake lever sets at desired height (usually 711 to 813 from end of handle to floor).

B. Clearance between end of equalizer and stop should be 3mm on each side if one side is higher than the other. Loosen the adjusting nut on the high side and tighten nut on the low side on equivalent to 3mm clearance re-adjust stop screws when clearance exceed.

C. With brake' set tighten all stop screws (2) until they just touch band then back screws off one turn this is equivalent to 3mm clearance re-adjust stop screws when clearance exceed.

D. Anchored at one end.

E. The other end is actuated by lever mechanism that tightens the bands around the rims.

Brake blocks:

- Are mounted on the inside of the bands
- Contact the rotating rime when the brake is engaged.

LEVER MECHANISM:-

- Force the bands to close on the twining rims.
- The large angle of wrap and width of brake lining provides for a large contact area between the brake lining and brake flanges.

ECB:-

- Elmagco
- It acts as a retarder
- It slows input speed
- But, it will not bring the input speed to a complete stop.
- Normally the ECB is used during running in operation.

f). LUBRICATION SYSTEM:-

1. Bearings are grease lubricated.
2. Chains and sprockets are oil lubricated.
3. Oil changing period→ 6 MONTHS or condition of oil
4. Avoid excess greasing/oil.

LUBRICATION OF DRAW WORKS:-

	Type of lubrication	Grade	Capacity	Changing / greasing period	Psi
All chains	Oil lubrications	SS220	60USA gallon	6 month/ condition of oil	20-50
All bearings including toggling system and water stuffing box	Grease lubrication	EP2 lithium base grease	--	Daily / weekly	--

IMPORTANT PARAMETERS:-

Sl.no.	Description	Capacity/measures
1	LUB OIL SS220	230 lts.
2	OIL PR. ON GAUGE	20-50 psi
3	BRAKE COOLING WATER (D/W)	35 gpm
4	COOLING WATER (ECB)	50 gpm
5	WATER PR. ON GAUGE	50-75 psi
6	AIR PR. (TRANSMISSION CLUTCHES)	75 psi
7	AIR PR. (LOW & HIGH CLUTCHES)	150 psi
8	AIR PR. (SANDREEL CLUTCH)	90-110 psi
9	AIR PR. (ROTARY CLUTCH)	90-110 psi
10	BRAKE LEVER HEIGHT	710-810 mm
11	GUIDE ROLLER CAP	3.2 mm

CHAIN SPECIFICATIONS:-

Sl.no	Description	Chain Location	Quantity in nos.
A	1 ½" X 116 X Triplex	Input chain	2
B	2" X 46 X Doublex	Intermediate	1
C	2" X 56 X Doublex	Low Transmission	1
D	2" X 48 X Doublex	High Transmission	1
E	2" X 76 X Doublex	High Clutch	1
F	2" X 92 X Doublex	Low Clutch	1
G	2" X 76 X Singlex	CAT Head	1
H	2" X 78 X Singlex	Rotary Counter shaft	1
I	2" X 108 X Doublex	Rotary Chain	1

g). COOLING SYSTEM:-

Cooling water for brakes

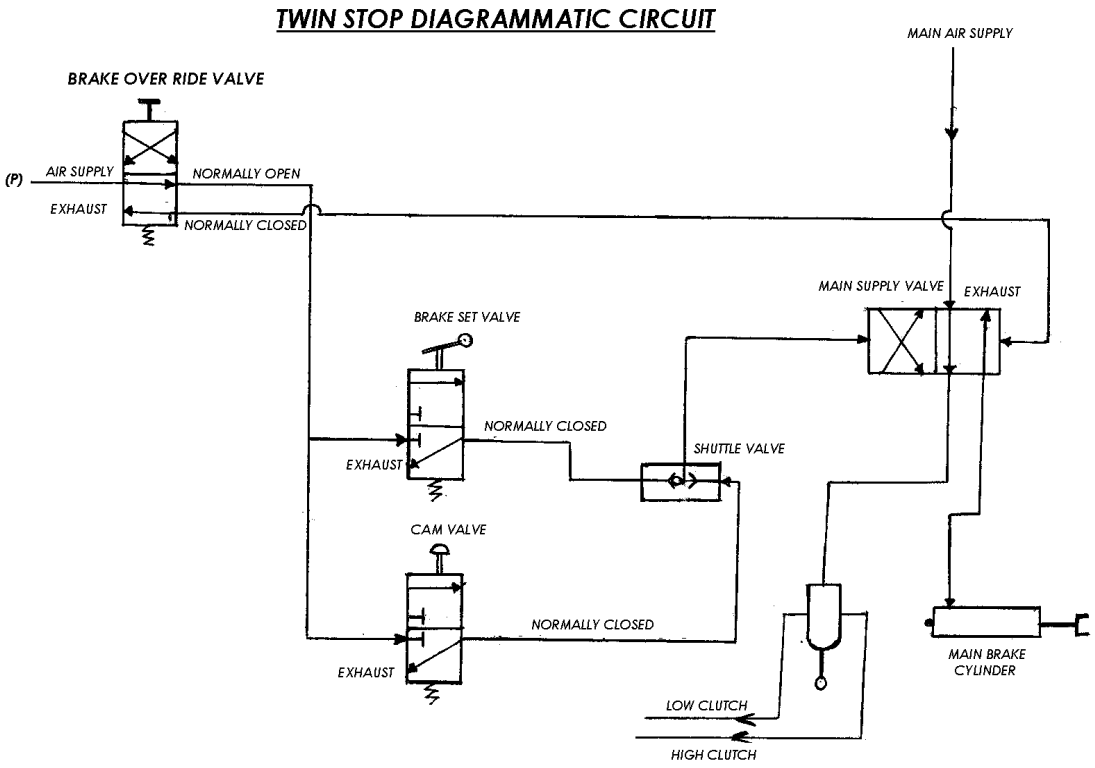
Brakes	Gpm	Psi
Drum brake	35	50-75
ECB	50	50-75

h). DRAWWORKS PNEUMATIC SYSTEMS AND ITS FUNCTION:-

Draw works is a most important and critical equipment of drilling rig. Understanding about draw works mechanism and pneumatic system will give us better idea about operation and maintenance.

The pneumatic circuit specially prepared for easy understanding about various lines, valves and flow path of the circuit is given below. One can easily identify the fault by tracing line or valve or working component by understanding the circuit. The functions of each valve are also given for

understanding about working principle and important for draw works safety. Each valve is important and most significant for smooth and successful operation of draw works. The operator can operate and control the draw works through pneumatic control valves mounted on the driller's console.



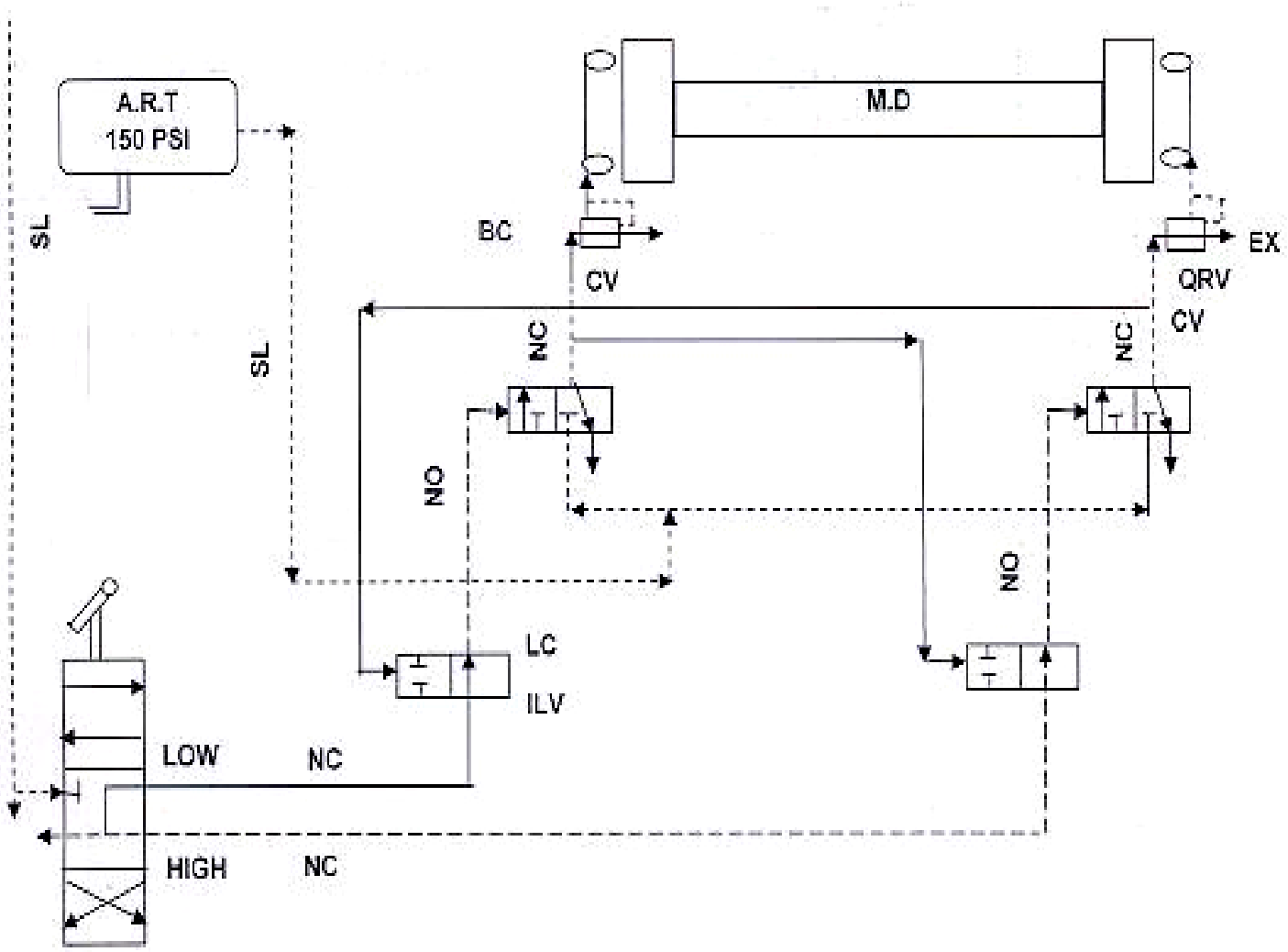
Twin stop is a simple pneumatic control device to limit the travel of the hook block in both directions (i.e. between derrick floor and crown block). The circuit diagram specially prepared for better understanding about working principles of various controlling valves, easy identification of various lines and find out the problem during fault.

Two cam lobes are to be fixed with respect to the device position of hook block. When either of the cam valve opens and sends a set pilot pressure to the main supply valve through the shuttle valve in the cam enclosure. This pressure blocks air supply to clutch valve and releases air to actuate the brake cylinder and engage the brake.

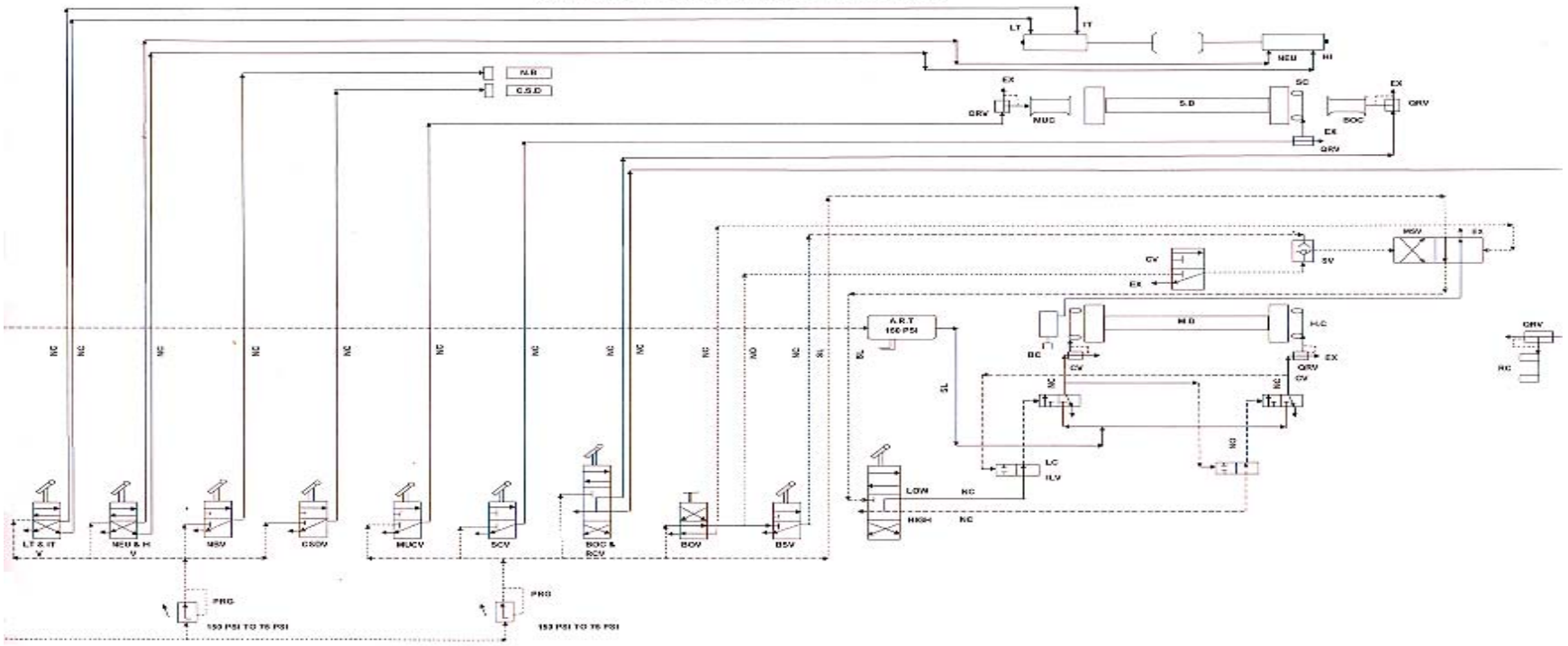
Another source of a set pilot pressure is the brake-set valve mounted on the control panel (emergency brake). In the normal position the set pilot pressure is blocked and down stream pressure exhausted allowing free travel of the block. In the set position (i.e. engaged position emergency brake valve) the set pilot pressure is passed to the main supply valve through shuttle valve to actuate the brake cylinder piston. The shuttle valve allows only one set pressure either from cam valve or brake set valve (emergency valve provided in the driller's console). Both the cam and brake set valves receive air supply through over ride valve, which can be mounted either on the control panel or on the floor.

As the over ride valve is actuated, the air supply to both these valves is blocked and downstream pressure is exhausted. At the same time, an over ride pilot pressure goes to the main supply valve causing it to block air to and exhaust air from the twin stop braking system, and supply air simultaneously to Draw works clutch valve. If the brake set valve is in the set position or the cam valve is in the tripped position, the brake will get engaged as soon as the over ride valve is released. In normal operation, the brake set valve is moved from set position. When the over-ride valve is depressed and system is reset.

LOW & HIGH CLUTCH DIAGRAMATIC CIRCUIT



PNEUATIC SYSTEM OF E760 DRAW WORKS



WORKING PRINCIPLES OF DRAW WORKS PNEUMATIC SYSTEM:-

The low/high clutch valve (normally closed in the neutral position) mounted on the driller's console receives compressed air from main valve of twin stop. The moment driller engages the low clutch valve, the air from low clutch valve passing into low clutch interlock valve. This low clutch interlock valve normally open position immediately allows the same air to low clutch relay valve for pilot operation. This air operates the low relay valve to open its port, which in turn allows the main air supply through check valve to low clutch for operation. A small quantity of air is immediately pass on to high clutch interlock valve to close the high clutch airline passage to prevent accidental engagement of high clutch at the same time. The interlock valve acting as a safety valve prevents simultaneous engagement of both the clutch at a time. While disengaging the low clutch valve, the air to pilot operation of low relay valve is stopped immediately and main supply port to low clutch is cutoff. Now the check valve allows the small quantity of air to vent from low clutch supply line. Because of this there will be pressure different before and after quick release valve. Now the quick release valve quickly acts and vents the low clutch air to atmosphere. The same principle will follow while engaging high clutch. The symbols and functions of pneumatic valves are given elaborately for easy understanding.

Draw work pneumatic system consists of

- ✓ Signal components--Valves
- ✓ Controlling components-Valves
- ✓ Working part- air motors, clutches, brakes cylinders etc.

TYPE OF VALVES:-

1. Directional control valve
2. Non-return valve
3. Pressure control valve
4. Flow control valve
5. Shut-off valve

The various types of valves are used in the pneumatic system to control, regulate and direct the flow of compressed air according to operational requirement

VARIOUS TYPES OF PNEUMATIC VALVES AND THEIR FUNCTIONS:-

Sl.no.	Description	Functions
01	Directional control valve	On/off function
02	Over ride valve	Cracking pressure
03	Relief valve	Limiting pressure
04	Pressure reducing valve	Reducing pressure
05	Flow control valve	Regulate flow
06	Check valve	Permits flow of air in one direction
07	Shuttle valve	Permits flow of air in two direction
08	Normally open (Solenoid valve)	Normally open position
09	Normally closed (Solenoid valve)	Normally closed position

NOTE:-

Moisture and impurities are worst enemy of pneumatic valves and its system function. It leads to fast worn out of moving parts,

malfunctions, and system failure and ultimately increase maintenance cost. Therefore moisture free air is must for proper functions of pneumatic valves and its system. Air dryer function is must for pneumatic system of drilling rigs.

Important specifications

- Run out for Brake drum – 0.25 mm
- Run out for clutch drum – 0.4mm
- Alignment between sprocket – 0.8 mm
- Slackness of chain – 0.089”
- End float of main drum shaft –- 12 mm
- Clearance between clutch and drum – 1.5 mm
- Operating temperature – 80^{o} C
- Sprocket surface hardening(thickness) - 10-12 mm
- Fixed end at low clutch side
- Floating end at high clutch side

IMPORTANT POINTS TO REMEMBER

- ✓ All shafts are supported on self-aligning spherical roller bearings except high and low clutch drum sprocket. They are non – adjustable heavy-duty straight roller bearings.
- ✓ The draw works shafts are provided with tapered end provision for quick removal of all end members on the shafts.
- ✓ 32VC 1000 constriction type air clutch is used for maximum heat dissipation required in the rugged use of drum clutches.
- ✓ Interlock system is provided in the draw works pneumatic circuit to avoid accidental engagement of both clutches at a time.

- ✓ Transmission clutches are spline type and air shifted from the driller's position. The spline type clutch has been provided in the transmission system to obtain minimum backlash and reduce impact or shock loads as compared to the jaw type clutch.
- ✓ Fan type spray nozzles are provided in the draw works lubrication system.
- ✓ The self-energizing type 306 main brake system is provided in the E760 draw works. This has high ratio of brake rim diameter to drum spool diameter for maximum braking effect.
- ✓ Clutch shifting is completely air controlled from the driller's console.
- ✓ The draw works will ordinarily be moved in three pieces- main sections, rotary countershaft section and motor skid.
- ✓ An adequate supply of cooling water is essential for satisfactory brake performance.
- ✓ Proper lubrication and adjustment are essential to long bearing life. Taper roller bearings may be adjusted by shim removal between the bearing retainer and sprocket of each shaft. Spherical roller bearings require no adjustment. Straight roller bearings under drum shaft sprockets require no adjustment.
- ✓ Friction shoes with replaceable linings should be replaced when the friction material has worn down approximately $_{2/3}^{rd}$ of its original thickness.

DO:-

1. If the low or high clutch is continuously engaging with drum while the pneumatic valve (low/high) is off position, then it is the failure of valve on the driller's console. This valve partially supplies air to pilot

operated relay valve which needs to be repaired/replaced (or) Clutch shoes retainer springs tension is also to be checked for clutch release if required change the spring.

2. If releasing of air from the clutch is delayed, then cleaning is to be done on the quick release valve diaphragm.
3. If clutch slips on load, it may be due to less air pressure, malfunction of interlock valve or relay valve. Check and correct fault accordingly.
4. a) If tracking or delay in disengagement of catheads, then check the malfunctions of cathead operating valve or of quick release valve.

   b) If tracking is in the catheads, spring tension is more in the (just bottom of the) cathead. This needs to be adjusted.

   c) If cathead is not taking full load, it is due to inadequate air pressure or spring tension. The air pressure must be checked and ensured110psi or adjust the spring tension if required.

5. If the brake cylinder is continuously engaging position, then malfunction of main valve or wrong air line connection in the crown-o-matic circuit. Check and correct it.
6. If braking effect is less, it is due to unequal 3setting of brake bands. Set the brake bands by keeping equal gap in both sides of the equalizer beam but not counting number of threads in the eyebolts.
7. Frequent failures of chains are due to misalignment/starvation of lubricant/shear of shear pins/looseness of chain/ overload etc. Check the causes and correct it.
8. Too much ply in the sprocket is due to bearing clearance, worn out retainer plate or bolt looseness in the retainer plate. Check and correct it. If required add to or remove shims from retainer plate to arrest ply.

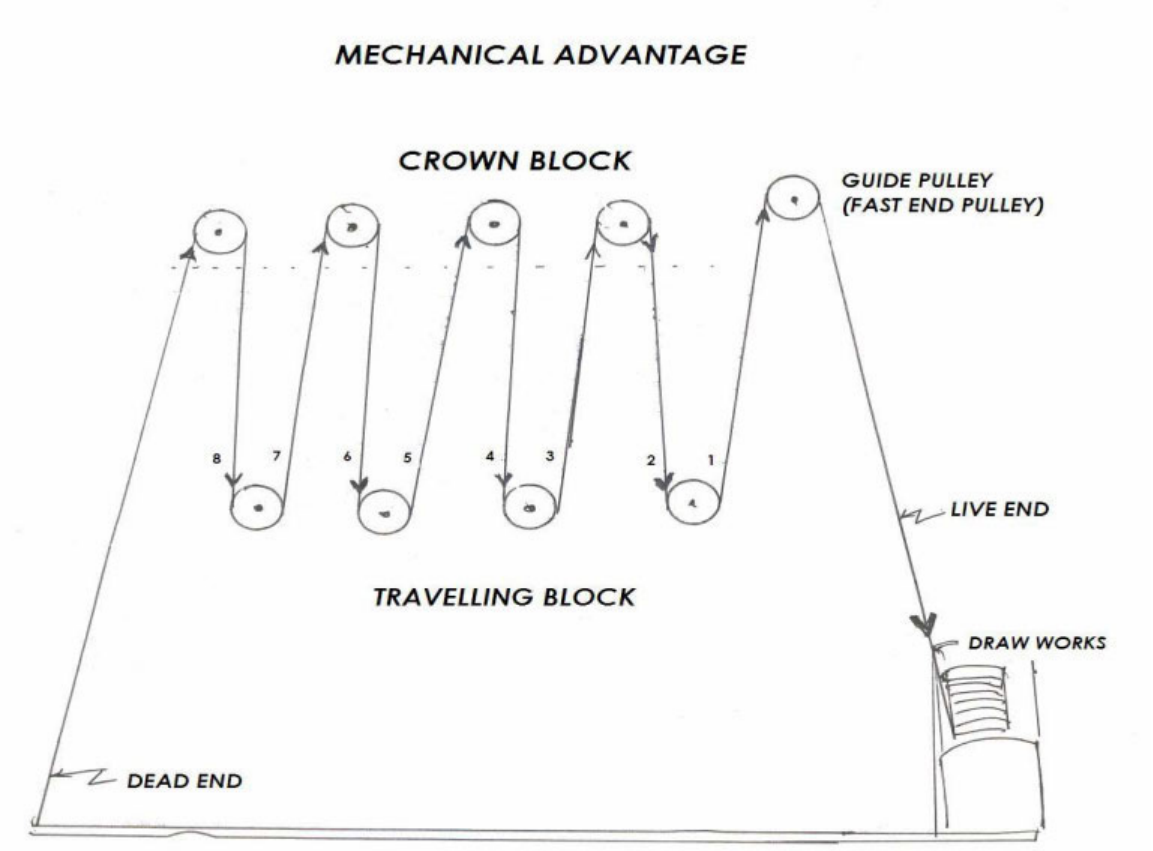
9. Keep 2psi air supply to electrical panel of driller's console to prevent inflammable gas enters into it to avoid fire.
10. Daily physical checks are required before and after starting the equipment to identify any abnormality that will help us to rectify the problem in time.
11. Set kick off rollers in place to avoid damages to casing rope and brake drum.
12. Set brake band guide rollers to maintain uniform gap between brake drum and shoes to avoid touching of brake shoes in the top due to gravity. Improper setting of rollers will allow the shoes to warn out unevenly.

DON'T ;-

1. Avoid excessive greasing of bearings. It overheats the bearings and also damages the seals of bearings.
2. Don't inflate the clutch without having the friction drum in place, as this may cause permanent damage to the clutch-actuating element.
3. Don't run the draw works on load with less than120psi (operating pressure of compressed air in the clutches). It is unsafe for operation.
4. Don't bypass the crown- o- matic by removing cam from the device. This leads to severe accident.
5. Don't run the draw works without cooling water. Brake will not work properly.
6. Don't run the draw works without ensuring adequate lubrication of chains.
7. Don't lift the load with ineffective brake system.

3. Crown block:

- It is a stationary pulley assembly mounted on the top of derrick (or) mast to provide leverage point.
- The function of sheaves is to guide and support the drilling line as it passes through the blocks.
- The number of sheaves in a block is determined by the weight to be supported.



TOTAL WEIGHT	*= 120 Tons*
No. of Incoming and Outgoing wire rope from Travelling block	*= 8 Lines*
Power requirement of Draw works to hoist 120Tonsweight	*= 120/8 = 15 Tons*

Mechanical advantage:-

Total weight (Traveling block + hook + swivel + Kelly + drill pipe + drill collar + bit)	= 100 tons
No. of lines (incoming + outgoing) from traveling block	= 10
Therefore hoisting line load	= 100/10
	= 10 ton

Note: Sheave blocks allow the hoisting line load to be reduced.

4. Travelling block:-

- ✓ The pulley block moving inside the derrick is called travelling block.
- ✓ The travelling block moves up and down between derrick floor and near to crown block on the line.
- ✓ The travelling block carries the hook that supports the drill string during drilling and its elevator bails that holds the elevators during round trip.
- ✓ The selection of travelling block depends on its load carrying capacity required for drilling operation.
- ✓ The sheaves are precision balanced and operate on heavy duty roller bearings.
- ✓ The large diameter center pin is made of heat treated high carbon steel. It is designed for maximum rigidity and strength.
- ✓ Easily removable strong steel plates are provided for safety.

DO

- ✓ Grease is to be done judicially as per maintenance schedule.
- ✓ Ply is to be checked during every rig building to see any abnormality.
- ✓ Groove diameter is to be measured for wear out limit.
- ✓ Ensure safety guards are in place and secured.

DON'T

- ✓ Don't keep the travelling block in the floor to avoid foreign particles entry.

MODEL AND CAPACITY OF TRAVELLING:-

Sl.no.	Description	Unit	Capacity	Capacity
01	Model	Tons	350	500
02	Load capacity	Tons	350	500
03	Sheaves	Nos	5	6
04	Outside dia of sheaves	Inches	42	50
05	Wire line size	Inches	1¼	1¼ or 13/8
06	Center pin diameter	Inches	8	10
07	Overall width	Inches	27	31¼
08	Overall height	Ft/in	6' 11	8' 83/4
09	Distance – center pin to top	Ft/in	28	30'¼
10	Weight	Pounds	8500	12830

The mechanical advantage in lifting a specific load is proportional to the number of lines in contact with the traveling block (i.e. the number of lines in and out of the traveling block)

It is this mechanical advantage, which permits extremely heavy loads to be hoisted with a relative low line pull at the reeving mechanism (the draw works drum).

However, to gain this advantage, additional wire line is placed in service and the elevating rate of the traveling block must be reduced or the wire line reeving must be accelerated.

CALCULATION FOR REEL THE ROPE:-

Traveling block's travelling distance pulling the stand = 90 feet.

The draw works has to reel (with 6 sheaves in travelling block) = 1080 feet

(90 x 12=1080)

SPEED CACULATION OF SHEAVES:-

- No. of sheaves in the crown block ---------- 6
- No. of sheaves in the travelling block ---------- 5
- If the guide pulley speed of crown block ------ 1000rpm
- The fast end pulley speed of travelling -------- 9/10 x 1000 = 900
- The second pulley speed of crown block------ 8/10 x 900 = 720
- The second pulley speed of travelling block— 7/10 x 720 = 504
- The third pulley speed of crown block--------- 6/10 x 504 = 302.4
- The third pulley speed of travelling block-----5/10 x 302.4 = 151.20
- The fourth pulley speed of crown block------- 4/10 x 151.2 = 60.48
- The fourth pulley speed of travelling block--- 3/10 x 60.48 = 18.14
- The fifth pulley speed of crown block---------- 2/10 x 18.14 = 3.63
- The fifth pulley speed of travelling block----- 1/10 x 3.623 = 0.36
- The last pulley speed of crown block ----------0/10 x 0.36 = 0

5. Hook:

- Pulling and absorbing load shock developed by drilling operation.
- The hook is suspended from the travelling block to grasp the various pieces of equipment/components needed for drilling operation and round trip.
- The hook has swivel and position locks.
- The hook cushions the weight of the drill pipe so that tool joint threads are not damaged in making up or breaking out of the pipe.
- Hook prevents from twisting of wire ropes in the travelling block.

6. Swivel:-

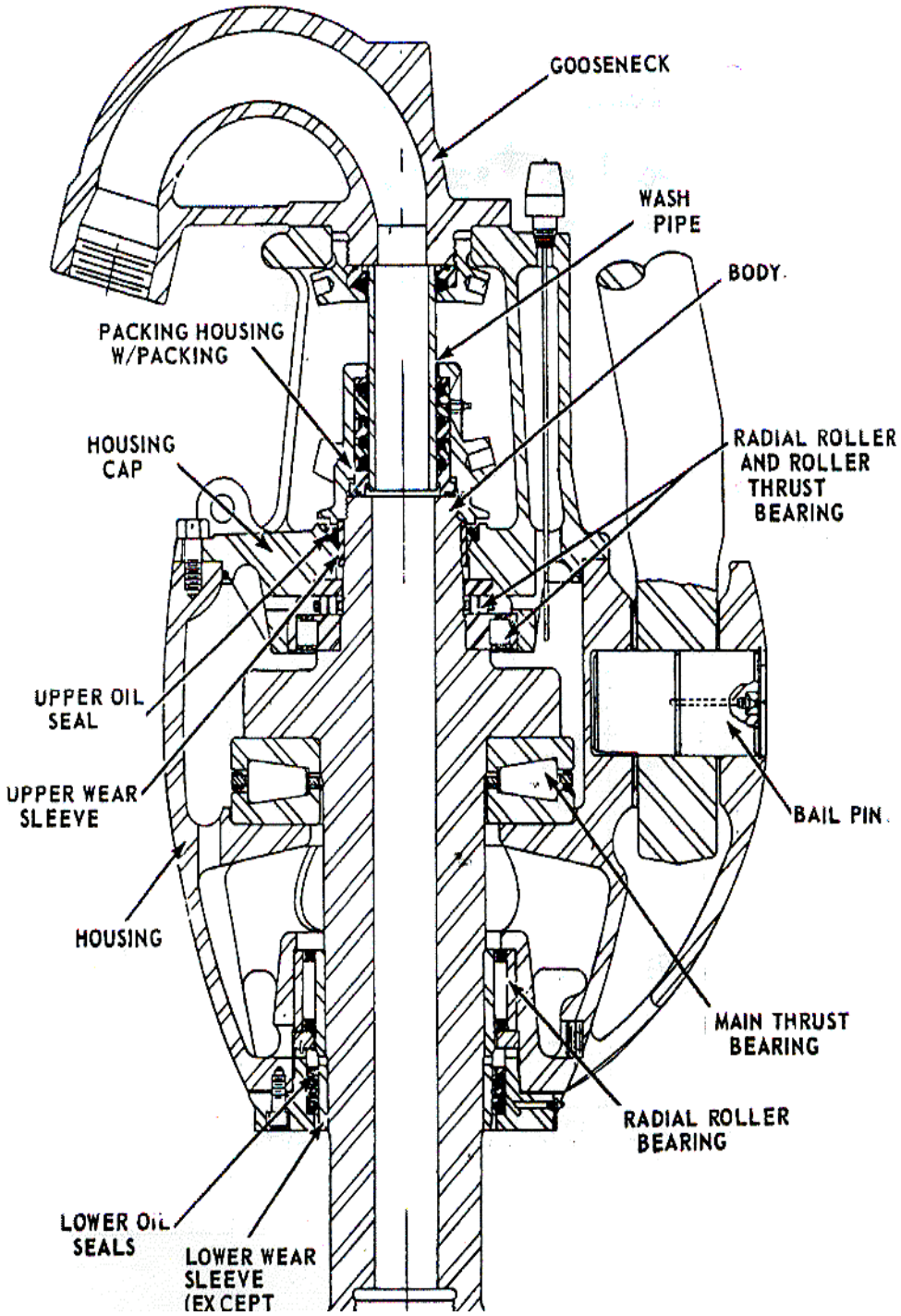
Swivel joints two parts to pivot freely. The rotation of drill string begins with swivel. The swivel prevents torque transmits to sheave block system. Its basic functions are

1. To support load
2. To allow drill stem to rotate
3. To support wash pipe and gooseneck
4. to Provide a connection for the rotary hose to drill string
5. To allow drilling fluid into the Kelly and drill string.

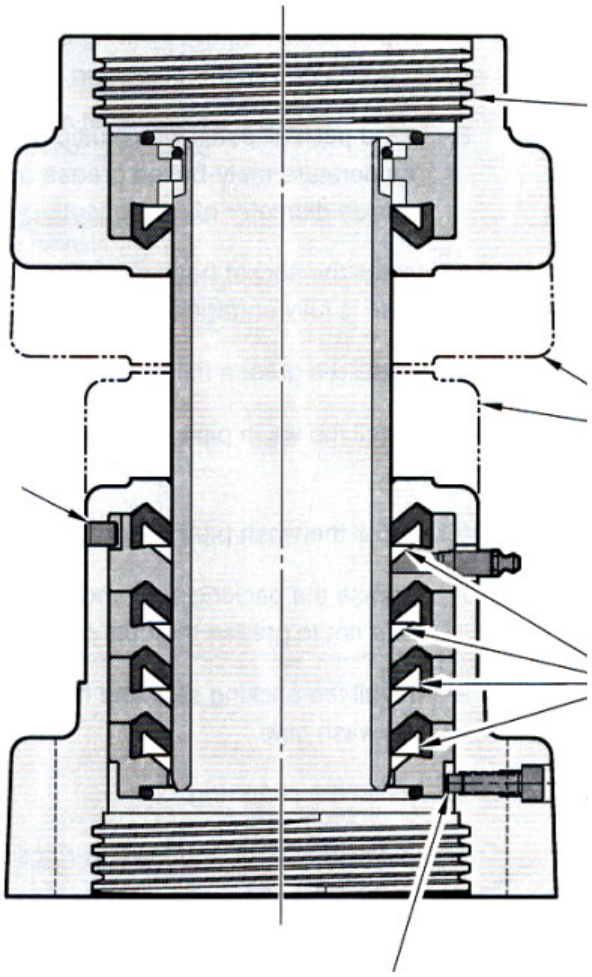
MODEL

- : PC300
- : Load capacity = 300tons
- : 41/2" drill pipe
- : Fluid passage 31/2"
- : Oil sump capacity 59 liters

SWIVEL


GOOSENECK
WASH PIPE
BODY
PACKING HOUSING W/PACKING
HOUSING CAP
RADIAL ROLLER AND ROLLER THRUST BEARING
UPPER OIL SEAL
UPPER WEAR SLEEVE
BAIL PIN
HOUSING
MAIN THRUST BEARING
RADIAL ROLLER BEARING
LOWER OIL SEALS
LOWER WEAR SLEEVE (EXCEPT

WASHPIPE ASSEMBLY



The wash pipe nut and the packing box have left – handed threads.

Slide the wash pipe nut and the packing box together for installation.

Dowel Pin

Hand pack all seals with multipurpose lithium – based or high – temperature moly – based grease completely filling the void

Ensure that the nose of the socket head dog nose screw is fully engaged in the groove of the lower spacer.

IMPORTANT POINTS TO REMEMBER

1. The main body of the swivel is supported in the housing by the main bearing and is stabilized by the auxiliary thrust bearing above and radial bearing below.
2. Main bearing carries the drill string load. It is of the full apex tapered roller type.
3. The auxiliary bearing located just above main bearing maintains precise centering of the rotating body in the swivel housing and also absorbs upward thrust forces. It is a heavy duty combination straight radial roller and roller thrust type.
4. Radial bearing located just below the main bearing in the housing centers the rotating body in the housing. The bearing is of the straight roller type.
5. Bearings are oil lubricated and they are continually submerged in the oil.
6. Oil seals prevent escape of oil and entrance of drilling fluid or other foreign matter.
7. Oil seals are grease lubricated and to be greased daily.
8. Breather is to be kept clean and obstruction free to avoid pressure buildup in the body due to heat expansion of oil. Failure to this may result in oil leakage at the housing oil seal, which is weakest part of swivel body.
9. The swivel housing is made up of steel casting internally ribbed to give maximum strength with minimum weight. It supports the bearings and act as oil path enclosure.
10. Wash pipe assembly is also another important part of swivel, which needs to be greased once in round trip.

DO

1. Keep the swivel always in the vertical position in the specially fabricate platform.
2. Disconnect the Kelly from the swivel while transportation.
3. Top up proper oil up to the mark.
4. Clean the breather to vent the gases from the swivel oil sump.
5. Daily physical checks are to be done before and after starting the equipment to identify any abnormality that will help us to rectify the problem.

DON'T

1. Don't fill up oil full of housing. The oil will expand due to temperature raise during operation and pressure buildups inside the housing ultimately damage the oil seal.

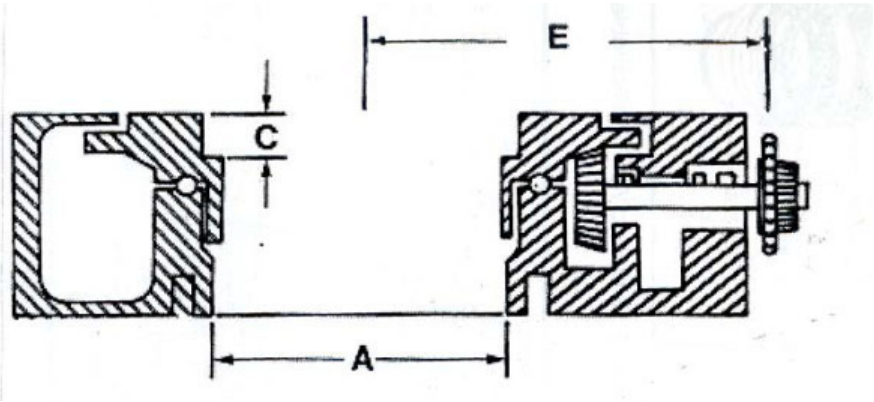
2. Don't lift the swivel with Kelly in the horizontal position because the bearings of swivel will not take horizontal loads.

3. Don't keep the swivel in the slanting position. It damages the bearings.

4. Rotary hose is rotating with swivel is the failure of swivel bearing. Don't allow to run further without rectification of problems.

7. ROTARY TABLE:-

Rotary table supports the weight of any pipe (or) casing run into (or) from the hole. It provides rotary motion to the drill string via Kelly to drill bit. The main bearing completely supports the turntable and its drill-string load and also provides a centering effect for the turntable because of the angular contact between the ball bearing and its race.



ROTARY TABLE - CROSS SECTION

A – Nominal diameter of rotary hole = 27½”

C-- ---------- 5¼”

E-Table size---44”

Sl.no.	Description	A 20½	A 27½	A 37½
01	Capacity -tons	320	465	650
02	Speed-rpm (maxi)	500	500	500
03	Oil pan capacity (liter)	23	32	45

IMPORTANT POINTS TO REMEMBER:-

1. Hold down ring serve as a steadying bearing, absorbs upward thrusts develop through turntable. And provide oil return to the oil reservoir in the base and prevents the escape of any oil from the oil bath system.

2. Labyrinth seals at both top and bottom of the turntable protect the oil bath from contamination from outside foreign matter.

3. A flexible seal ring attached to the bottom of the hold-down ring, prevents mud from entering the system in case of a well kick or a blow out. The flexible lip of the ring bends upward under the force of a stream of mud, forming an effective seal.

4. The pinion shaft inner bearings are tapered roller type and are located at the pinion end of the pinion shaft. They absorb radial and thrust loads as well as maintain proper tolerance between the pinion and ring gear. A spherical roller outer bearing at the sprocket end of the pinion shaft absorbs the radial load transmitted through the drive sprocket.

5. The rotating pinion, dipping into the reservoir carries oil to the ring-gear, from which it drips continuously to the turntable ball bearing, guided by a trough.

6. Backlash between the teeth of the pinion and the ring gear is adjusted by means of the lower ball-race shims. To increase backlash, add shims. To decrease backlash, remove shims. This backlash should vary between 0.025 in to 0.035 in.

7. Clearance between the hold-down ring and the hold-down ring bushing should be adjusted by a series of tests. First install an excessive numbers of hold-down ring shims. Then remove the shims until a slight drag is felt while rotating the turntable by hand. Add one 0.015in shims for proper running clearance.

DO:-

1. Do greasing of all points as per maintenance schedule judicially.

2. Daily physical checks before and after running of equipment for any abnormality will help us to rectify the problem.

3. Clean the breather to vent the gases from the oil sump and avoid labyrinth seal damage due to pressure buildup inside the oil sump.

4. Align the mast center to rotary bore center to avoid one side track which will damage the rotary.

DON'T:-

- ✓ Don't allow to engage the rotary lock for pipe breaking. It leads to accident and damage the rotary table.
- ✓ Don't allow to keep the heavy weights on the top cover of rotary table. It will bend and touch the rotating member of the rotary table.

HOISTING SYSTEM OF E-1400

DRAW WORKS E - 1400

Model - E1400

Draw works capacity - 1400 hp

Motor capacity - 750 KW

Motor speed - 1080 rpm

Draw works speed ratio - 16.875: 1

The draw works is powered with two DC motors of 1000 hp each. Either one or both of these motors can be put into operation at a time. The additional motor is only for standby operation. Draw works is the heart of the drilling operation without which no work can be performed on the derrick floor. It requires more care and maintenance due to involvement of different mechanisms, rugged use, severity and frequency of operation. More over it doesn't have any standby.

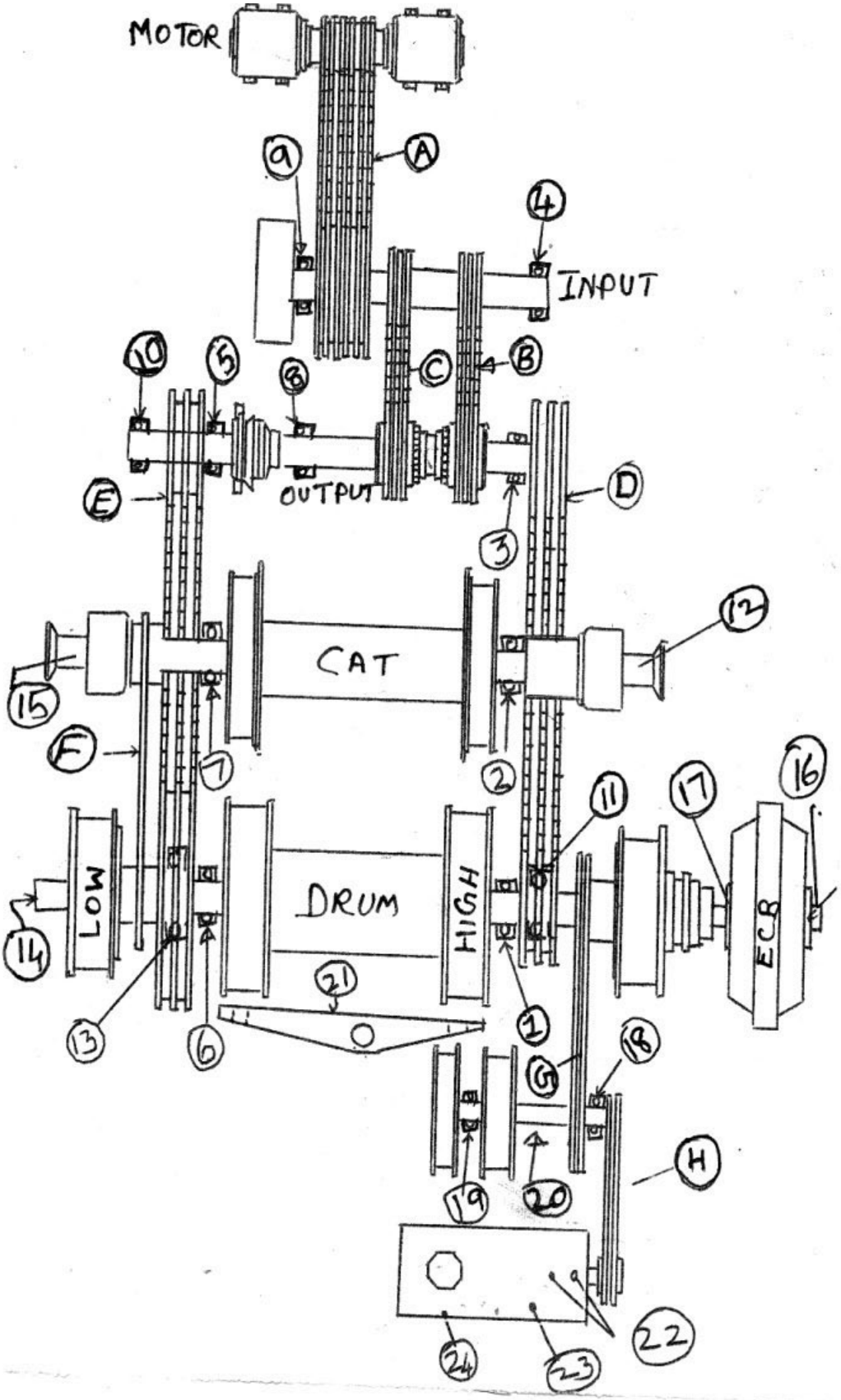
Draw works consists of

1. Prime mover.
2. Transmission system.
3. Hoisting system.
4. Brake system.
5. Lubrication system.
6. Cooling system.
7. Pneumatic control system.

1. PRIME MOVER: (DC motors)

- Are prime movers of Draw works
- Convert electrical energy input to mechanical energy
- Provide mechanical energy input to the draw works.
- Suitable to variable speed requirement of draw works.

2. TRANSMISSION OF E-1400 DRAW WORKS



3. SPEED CALCULATION

I. Input shaft speed (28/51x1080rpm) - 593 rpm

II. Output shaft speed - 282 rpm & 451 rpm

Low Transmission	20/42 X 593	282rpm
High transmission	19/25 X 593	451rpm

III. Low clutch speeds – 64 rpm& 103 rpm

IV. High clutch speeds—243 rpm & 388rpm

	Low transmission	High transmission
Low clutch	19/83X 282=64 rpm	19/83X451=103rpm
High clutch	37/43 X282=243 rpm	37/43X451=388rpm

V. Rotary counter shaft speeds 282 rpm & 451rpm

Rotary counter shaft RPM

Output shaft	R/c	Rpm
Low	43/37 X 243	282
High	43/37 X 388	451

VI. Rotary input rpm 494, 789

Rotary input RPM

R/c shaft	Rotary input	Rpm
Low	35/20 X 282	494
High	35/20 X 451	789

VII. Rotary turntable rpm: 129,205

Rotary table RPM

ROTARY PINION	TURNTABLE	RPM
LOW	20/77 X 494	129
HIGH	20/77 X 789	205

Cathead RPM

Low clutch	Cat head	Rpm
Low	39/21 X 64	119
High	39/21 X 103	191

MAIN DRUM SIZE

1. Drum size: 28” x 52”
2. Drum brake: 50” x 10”
3. Low & High clutches: Air flexes 38VC1200
4. Rotary clutch: Airflex24VC650
5. Sand reel clutch: Airflex24CB500

CLUTCH SPECIFICATION:-

Sl.no.	Rig E1400 equipment	Description	Clutch drum size (dia. x width)	Maximum allowable wear on drum dia.	Minimum allowable drum dia.	Minimum allowable lining thickness
01	Draw works low & high clutches	38 VC 1200	38" x 12"	3/16"	38"-3/16" = 37x 13/16"	3/8"
02	Rotary clutch	24VC650	24" x 6.5"	1/8"	24"- 1/8"= 23 x 7/8"	5/32"
03	Sandreel	24CB500	24"x 5"			

RECOMMENDED MAXIMUM HOOK LOADS IN TONNES WITH 12 LINES

Clutches	Transmission	
	Low	High
Low	295	168
High	99	64

IMPORTANT PARAMETERS:-

Sl.no.	Description	Capacity/measures
1	LUB OIL SS220	230 lts.
2	OIL PR. ON GAUGE	20-50 psi
3	BRAKE COOLING WATER (D/W)	35 gpm
4	COOLING WATER (ECB)	50 gpm
5	WATER PR. ON GAUGE	50-75 psi
6	AIR PR. (TRANSMISSION CLUTCHES)	75 psi
7	AIR PR. (LOW & HIGH CLUTCHES)	150 psi
8	AIR PR. (SANDREEL CLUTCH)	90-110 psi
9	AIR PR. (ROTARY CLUTCH)	90-110 psi
10	BRAKE LEVER HEIGHT	710-810 mm
11	GUIDE ROLLER CAP	3.2 mm

NOTE:

1. All bearings are grease lubricated
2. Chains and sprockets are oil lubricated
3. Oil changing period 6months
4. Avoid excess greasing

CHAIN SPECIFICATION:-

Sl.no	Description	Chain Location	Quantity in nos.
A	1 ½" X 114 X Triplex	Input chain	2
B	2" X 46 X Triplex	High Transmission	1
C	2" X 56 X Triplex	Low Transmission	1
D	2" X 82 X Triplex	High clutch	1

E	2" X 98 X Triplex	Low Clutch	1
F	2" X 82 X Single	CAT Head	1
G	2" X 88 X Doublex	Rotary Counter shaft	1
H	2" X 112X Doublex	Rotary drive	1

XI. INDEPENDENT ROTARY DRIVE

- ✓ The main purpose of installing the independent rotary drive system in the drilling rig E1400-19 is to eliminate the drive from draw works to rotary table to save energy. The draw works function is not required during drilling operation.
- ✓ The independent rotary drive system consists of DC motor, clutch, gear box assembly and couplings for connections.
- ✓ The motor (4903CX) is coupled to the transmission RT2010D by a flexible gear coupling and the transmission is connected to the rotary pinion shaft through a chain coupling.
- ✓ The braking is provided by the arrangement of a brake drum and an air flex clutch 20VC600. The drum is mounted on the motor adapter and the clutch is assembled over the drum. The clutch is made stationary by bolting it to the clutch carrier and the carrier is bolted to the transmission skid.
- ✓ Separate lub. Oil pump is provided with gear assembly for forced lubrication.
- ✓ IRD is mounted on an independent skid.

MODEL: - RT2010D

Where

- R- Rotary
- T – Transmission
- 2 – No of speed forward (no of speed 2)
- 0 – No of speed reverse
- 10- 1000hp
- D- Location of input shaft down

IMPORTANT POINTS TO REMEMBER:-

- By installing the IRD, the drive to the rotary table from the draw works is eliminated.
- Drive to rotary table by an Independent D.C.motor through a 2-speed transmission system (i.e. a gear box).
- The braking is provided by the arrangement of a brake drum and an air flex clutch model: 20 VC-600.
- The clearance between the two sprockets of the chain coupling is 3.5$\pm$0.5mm.
- The gears in these units are single helical type and operate on parallel axes.
- The high or low speed output is selected by the engagement of spline clutch for which an external lever is provided.
- An external lubrication system is provided for lubrication of gears and bearings.
- The axial clearance of main bearing is between 0.004 to 0.006”
- Couplings are greasing lubricated (EP2).
- Grade of oil ----------HP140
- Oil capacity is ----------30 liters.
- High lubrication temperature----------180^{o}F

- Oil pressure----------1.8 kg/mm^2 to 2.5 kg/mm^2
- Input shaft dia. ----------3.94 inches.
- Input shaft keyway----------1 x ¾ inches
- Output shaft dia. ----------3.94 inches.
- Output shaft keyway----------1 x ¾ inches
- Weight of gear box unit----------1000 kgs

OPERATIONAL SPARES:-

Sl.no	Part name	Part no	Quantity
01	Coupling, chain (rotary half)	2-96948-1-0614	1
02	Coupling, chain (trans.half)	2-96948-1-0613	1
03	Chain ANSI 200H-1 X 18P	R1022	1
04	Hose assy.	45-171-898	1
05	Quick release valve	06-000-391	1
06	Air flex clutch 20VC600	06-001-882	1
07	Hose assy.	45-171-799	1
08	Flex hose assy	45-171-775	1

TRANSMISSION:-

Sl.no	Input shaft	Output shaft	
		Low gear	High gear
01	Input speed 1100rpm	1240rpm	566rpm
02	Gear ratio	1.767:1	1:1.128
03	Rated input IHP	600	1000
04	Stall torque Ft lb	5000	7000

DO

- ✓ Check the flexible gear coupling for proper lubrication.
- ✓ Check for the concentric clearance between the clutch drum and clutch.
- ✓ Check for proper functioning of the lubrication system for the transmission.
- ✓ Ensure proper seating of the skid and tightening of bolts.
- ✓ Check and verify the clearance between the two sprockets of the chain coupling (i.e. 3.5±0.5mm).
- ✓ Check and ensure proper lubrication to the transmission.
- ✓ Ensure adequate air supply to clutch for effective function of brake system.

DON'T:-

- ✓ Don't apply excessive torque on rotary. It may leads to failure of rotary table. The maximum allowable current for maximum torque on rotary table is 500 ampere.

TOP DRIVE SYSTEM:-

The main purpose of installing the top drive system in the drilling rig E1400-09 is to eliminate the drive from draw works to rotary table to swivel to drill string during drilling operation to save energy. It will also help us to reduce manual activities in the derrick floor and facilitate quicker and faster pipe connection to save time.

MODEL: TDS-11SA

TDS----Top Drive System

11------11th Model

S--------Swivable

A--------Assembly

IMPORTANT POINTS TO REMEMBER:-

- Maximum operating pressure of hydraulic system is up to 3000psi
- Maximum operating pressure of Pneumatic system is 150psi
- Power requirement ----------700KVA
- Maximum capacity of each motor (400 hp each x 2) = 800HP
- Output torque----------37500 ft lb(800hp)
- Maximum speed at full power ----------228rpm
- Hoisting capacity----------500ton
- Transmission ratio---------- 10.5: 1
- If the primary gear mesh backlash exceeds 0.030 inch. Or the secondary gear mesh backlash exceeds 0.040 inch. Excessive gear wear or bearing failure may be indicated.
- A 10 hp, 1800rpm, AC motor, drives two hydraulic pumps and powers the hydraulic system. A fixed displacement pump drives the lube oil system motor. A variable displacement pump provides hydraulic power for the AC motor brakes, powered rotation head, remote actuated IBOP, pipe backup clamp cylinder, link tilt, and counterbalance system.

INSPECTING THE UPPER MAINSHAFT LINER:-

- Remove the wash pipe assembly.
- Check the upper main shaft liner for erosion caused by leaking wash pipe packing and replace the liner if erosion is found.
- The poly pack seal must also be replaced whenever the upper stem liner is replaced.
- Grease the poly pack seal and clean the main shaft bore before re-installing.

- Make sure the O-ring of the seal is facing down when the seal is installed on the liner.

GREASE POINTS:-

Sl.no	Description	AC drilling motor	AC blower motor	AC motor (Hydraulic pump)
01	Number of motors	2	2	1
01	Black pearl EP2 grease	4points	4points	2points
02	Grease interval	3months	3months	3months
03	Capacity	400hp	5hp	10hp
04	RPM		3600RPM	1800rpm
05	FLOW			8gpm/3.5gpm (t high/ low speed)

Sl. no	Description	Gearbox lubrication	Hydraulic fluid
01	Oil grade	Servo mesh SP320	Servo system HLP 46
02	Quantity	15gal/57 lts	25gal/95lts
03	Operating temperature	20 to 200^{o}F(maxi.)	-10^{o} to 85^{o}C
04	Oil change interval	6months	6months
05	Replacement of oil filter	3months P/N: 111013-1	3months P/N: 114416-1

CONSUMABLES:-

Sl. no	Consumable parts	Part number	Quantity
01	Tong Dies	16401-2	4
02	Stabilizer, Front	118368	1
03	Stabilizer, Rear	118367	1
04	Guide Arm (Stabbing Guide Flippers)	76442	2
05	Wash Pipe (Standard)	30123289	1
06	Wash Pipe (Tungsten Coated, High Pressure)	30123289 – TC	1

07	Wash Pipe Assembly (Standard)	30123290	1
08	Wash Pipe Assembly (High Pressure)	30123290 – 1000	1
09	Wash Pipe Packing Kit, 3" standard (use with wash pipe 123289)	30123290 – PK	1
10	Wash Pipe Packing Kit, 3" High Pressure (use with wash pipe 123289 – TC only)	30123290-PK-1	1
11	Hydraulic Oil Filter	114416 – 1	1
12	Gear Oil Filter	111013 - 1	1
13	Brake Pads		8

XII. KHOLA COMPRESSORS

MODEL: - SESH1-155

- ✓ S—Stationary
- ✓ E --Electrical driven
- ✓ S –Screw
- ✓ H--High-pressure application
- ✓ 1--Single stage
- ✓ 155--Capacity cubic feet per minute

MODEL:-TDSH1275

- ✓ T—Transferable
- ✓ D--Diesel engine driven
- ✓ S--Screw type compressor
- ✓ H--High-pressure application
- ✓ 1---Single stage
- ✓ 275--Capacity cubic feet per minute

NOTE:

- ✓ Less than 7 kg/cm^2 low-pressure application
- ✓ More than 7 kg/cm^2 high-pressure application

XIII. SWIVEL

Model: PC425

- ✓ Load capacity: 425 tons
- ✓ Drill pipe size 41/2”
- ✓ Fluid passage 31/2”
- ✓ Oil sump capacity 191/2 Gallons

XIV. TRAVELLING BLOCK:

- ✓ Capacity: 500Tons
- ✓ No of sheaves 6
- ✓ Out side diameter of sheaves 42”
- ✓ Wire size 13/8”
- ✓ Centre pin dia. 10”
- ✓ Clevis bar pin dia 5”

MUD HANDLING EQUIPMENT

Mud is considered to be the blood of the well. Mud parameters are necessarily to be maintained well within the allowable parameters to drill a healthy well.

Mud system is one of the most important elements of a drilling rig. Mud system consists of mud mixing, mud cleaning and agitating. Mud processing and reconditioning equipment like mud hopper, shale shaker, degasser, de-sander, de-silter, mud agitators and mud guns are performing their functions to prepare and conditioning the mud and also keep the mud parameters well within the limit during drilling operations.

HOPPER SYSTEM:-

Mud hopper is used for mixing dry materials with the drilling fluid. Hopper system consists of centrifugal pumps and hoppers with jets. It is the first stage of mud handling system. The centrifugal pump charge the water/drilling fluid into the hopper through jet, which acts like a venturi, creates vacuum and suck the dry materials along with it.

NOTE: -

If any abstraction in the jet or pipe or jet dia. is more, the venture effect will not be there to carry away the dry mixture along with pressurized water of the centrifugal pump (hopper pump). So problem are to be identified fand corrective action needs to be done for proper function of hopper.

SOLID CONTROL EQUIPMENT:-

1. Shale shaker
2. Degasser

3. Desander
4. Desilter
5. Mud agitator
6. Mud guns

The purpose of solid control equipment is:-

1. To prepare the mud for drilling of a healthy well.
2. To remove solid and gas from mud.
3. To maintain the required parameters.
4. To avoid mud wastage by recycling.
5. To keep weighing material in suspension and avoid gel formation.
6. It aids reduction in consumption of mud pump expandable.
7. It aids saving of energy.
8. It aids saving of well cost.

DRILLING FLUID:-

The liquid drilling fluid is called drilling mud. It may be gas or liquid or combination of both. The drilling fluid should have the lowest viscosity possible at the bottom of the hole to achieve maximum chip removal and high viscosity in the annular to keep the cutting particles in suspension. Water base drilling fluid has these properties. It is basically a mixture of water, barite, bentonite and some chemical additives.

BARITE:-

Increase the density of mud (4.2 times more than water)

BENTONITE:-

Filtration control and increase yield point.

OIL MUD:-

It is used when the bottom hole temperature is high, drilling in high-pressure zone, instability of the well, smaller dia well, deep well and production formation is water sensitive.

PRIMARY FUNCTION OF DRILLING FLUID:-

- ✓ It prevents formation fluids from entering into the well bore.
- ✓ It prevents the formation from falling into the well bore.
- ✓ It keeps the well in good and healthy condition.
- ✓ It keeps cutting particles in suspension
- ✓ It removes cutting particles from bottom of the hole.
- ✓ It keeps the drill bit in cool condition to enhance drill bit life.
- ✓ It facilitates removal of gas at the surface.
- ✓ It handles contaminate/ harmful like H_2S.
- ✓ It protects the drilling string and casing pipes from tubular corrosion.
- ✓ It buoyancy the casing and drilling string.
- ✓ It facilitates easy removal of solid and gas by solid control equipment.
- ✓ It facilitates easy penetration of drill bit for faster drilling.

1. SHALE SHAKER:-

Shale shaker is first piece of solids control equipment on surface mud tanks to remove large particles coming out from the drilling well. It should be located above the sand trap on the first mud tank in the surface system. The discharge from the screens should be directed to a waste area and the clean fluid should return to the sand trap. The shaker's shaft should rotate toward the discharge end of the screen.

"g" factor determine shale shaker life.

$$\text{"g" factor} = \frac{\text{Stroke x RPM}}{7040}$$

"g" is less than 3 for conventional shale shaker.

Higher the "g" factor greater the solid separation.

Very high "g" factor reduce the life of screen.

"g" ∞ thrust

CAPACITY LIMIT OF SHALE SHAKER:-

1. Solid capacity limit- maxi. quantity of solid to be removed.
2. Liquid capacity limit- maxi. discharge volume is to be able handle while considering minimum screen size.

SHALE SHAKER CAPACITY:-

Sl.no.	Mud weight	Screen size	Single tandem	Dual tandem
01	1.20	20	3000 Lpm	6050 Lpm
02		30	2650 Lpm	3650 Lpm
03		40	2270 Lpm	4540 Lpm
04		50	1892 Lpm	3785 Lpm
05		60	1514 Lpm	3028 Lpm

CLASSIFICATION OF PARTICLES SIZE:-

Sl.no.	Particle size in micron	Classification
01	2000	Coarse
02	250 to 2000	Intermediate
03	74 to 250	Medium
04	44 to 74	Fine
05	2 to 44	Ultra fine
06	0 to 2	Colloidal

SIZE OF SOLIDS AND SHALE SHAKER SCREEN:-

Sl.no.	Screen size	Removal of solids in microns
01	12 x 12	1540
02	14 x 14	1230
03	16 x 16	1020
04	18 x 18	920
05	20 x 20	765
06	40 x 40	320
07	60 x 60	250
08	80 x 80	177
09	100 x 100	149

SHALE SHAKER MESH WEAVES:-

1. Plain Square weaves.
2. Rectangular opening
3. Plain notch weave
4. Twilled square weave

Sl.no.	Mesh size	Wire dia.in inch	Opening size in inches	Opening size in micron	Opening area
01	20 x 20	0.017	0.033	838	43.6
02	30 x 30	0.012	0.0213	541	40.8
03	40 x 40	0.010	0.015	381	36.8
04	40 x 20	0.014	0.012	310/910	36.8
05	60 x 60	0.0075	0.0092	234	30.5
06	60 x 40	0.009	0.0077	200/406	31.1
07	80 x 80	0.0055	0.007	178	31.4
08	80 x 40	0.007	0.0055	140/460	35.6

09	100 x 100	0.0045	0.0055	140	30.3
10	120 x 120	0.0037	0.00146	117	30.9
11	150 x 150	0.0026	0.0041	105	37.4

DIFFERENCE BETWEEN SQUARE & RECTANGULAR MESHES:-

Square mesh	Rectangular mesh
Remove more solid	Remove less solids
Shorter life	Longer life
% of opening area is less	% of opening area is high
GPM capacity is lower in the given shale shaker	GPM capacity is higher in the given shale shaker

FACTORS INFLEUNCE THE VIBRATION:-

1. The shaft should rotate toward discharge end of shale shaker (i.e. toward waste pit).
2. Correct belt tension is to be maintained for proper vibration.
3. Vibration mount is flexible enough to permit vibration of basket.
4. Fly weight must be tightened position in the shaft for proper vibration.
5. Adequate motor rpm is also influence the vibration of shale shaker basket.

DO:-

- ✓ Do all the checks necessary for proper vibration of shale shaker before and after running.
- ✓ Avoid excess greasing.

DO'T :-

- ✓ Don't run the shale shaker without safety guard.
- ✓ Avoid excess greasing of bearing.

FACTORS INFLEUNCE THE VIBRATION (LMS):-

1. Fly weight must be tight position in the shaft for proper vibration.
2. Fly weight must be rotate in the opposite direction in both the motors of a basket.
3. Spring tension (shock mount) must be adequate for proper vibration.
4. Slope angle is also to be maintained in the discharge end as per instruction of OEM.

2. DESANDER:-

The de-sander is used in the mud system for the purpose of removing sand-size particles. It is the second stage of solids removal program for weighted mud. A centrifugal pump should be used to feed desander with mud. This pump delivers smooth; even flows to the hydro cyclones for separation of desand particles. The pressure of feed should be 4 x mud weight. Low pressure will cause poor separation and high fluid loss. High pressure will cause high rates of hydro cyclone wear. The cones should operate with a spray discharge for maximum efficiency. Do not operate hydro cyclone with a rope discharge.

De-sander cones have an internal diameter of 6 to 12 inches. They have the advantage of handling large volumes per single cone but they do not remove coarse and fine particles. Desanders operate efficiently with lower pressures than small cones. Usually 30-35 psi is required for desander to function properly. Total head of about 70-80feet is normally provided. The unit should be kept normally 6 to 10 feet above the desander pump.

Pressure is the critical factor in obtaining maximum efficiency in desander and desilting with cone shaped centrifuges. If the pressure is not sufficient, solids do not separate well from the mud. If there is too much pressure, the service life of the units is drastically reduced. Most desander operates at about 35 psi and most desilters at 45 psi.

The most common causes of internal wear are excessive pump pressure to the cone unit and closer of the apex to such an extent that separated solids cannot escape, thus plugging the opening and preventing further separation.

3. DESILTER:-

The de-silter is used in the mud system for the purpose of removing silt particles. It is the third and final stage of solids removal program for weighted mud. A centrifugal pump should be used to feed desilter with mud. This pump delivers smooth, even flow to the hydro cyclones for separation of desilting particles.

Good desilters properly operated, reject all material of sand size, a high percentage of solids larger than 10-20 microns, and decreasing percentages of materials down to 2-3 microns. Total desilting of the mud in drilling can cut down drastically on mud pump wear, hole problems, bits, time required to drill the hole, water and chemicals required for mud treatment.

NOTE: For maximum removal efficiency, the discharge from the apex opening should be in the form of a spray rather than a rope discharge.

Sl.no	Description	Particle size in micron	Handling capacity in gpm	Pump size	Size	Working pressure in psi	Temperature
01	Shale shaker	250 to 2000	Maxi. delivery of MP	MP	5′ x 4′	-	
02	Desander	40 to 250	1500	6 x 8 x 13¼″ 1200rpm	12″	30-35	

03	Desilter	10 to 40	1500	6 x 8 x 13¼”1200rpm	4”	35-45	

4. MUD CLEANER:-

Mud cleaner is used in the solid control system to effectively remove drilled solids from weighted mud without excessive loss of barite and fluid. Mud cleaner is a combination of desilting hydro cyclones and a very fine mesh-vibrating screen to remove drilled solids while returning valuable mud additives and liquids back to the active system.

5. MUD AGITATOR:-

The agitator is a right angle gearbox having a set of gears with speed reduction ratio of 25:1. It has to rotate in the clockwise direction when viewed from its top. The agitator is powered by electric motor receives and transmits energy to impeller for stirring mud. The impeller keeps the mud in movement continuously to prevent gels from forming and maintaining weighing material in suspension.

6. MUD GUN:-

The mud gun is used in the mud system to stir the mud and thus avoid gel formation. Mud gun stands should be positioned around the mud pits so that the entire area can be stirred. Mud guns are usually connected to a manifold and supplied with mud from a pump operated for that specific purpose. The mud gun streams are directed at a particular position in the mud pit and produce a swirling or rolling action. Mud guns are quite useful to mix floating lost circulation material and carry it below the mud surface, where it is wetted and picked up by the main mud pump to be pumped into the well.

The purpose of using mud agitators and mud guns are:-

- ✓ To prevent weighting material from dropping out of suspension during the slow travel of mud through the pits.
- ✓ To break up gel strength mud.
- ✓ To reduce apparent viscosity of mud and permit gas bubbles to escape in miner gas cutting.
- ✓ To promote good mixing of mud when a jet hopper is used to add weighting material or clay to the system.

DEGASER:-

Degasser removes entrained gas from the gas cut mud coming out of drilling hole. It is necessary to maintain gas free mud to avoid cavitations problems of mud handling pumps for their optimum performance and also to control specific gravity of mud to maintain hydrostatic pressure of the well.

Degasser is normally kept just after shale shaker to remove gas from the mud before the desander pump handling the mud to avoid cavitations problem.

Mud enters the degasser through an 8″ riser pipe at the right end of the vessel. The suction port of the vacuum pump mounted on the top of the unit connected to left end of the vessel through pipes and three-way valve. The three-way valve again connected to a floater. The floater functions depend on mud level inside the vessel, which will open or close the three-way valve to the atmosphere and thus controls vacuum inside the vessel. The vacuum pump suck gas/air from the vessel and create the negative pressure of about 8 to 15 inches of mercury (3.2 to 6 psi), depending upon the weight of the mud to be raised into the unit.

The mud enters near the top of the horizontal vessel and flows along a section of large pipe that is closed at its far end. The top of the pipe is sliced away in a horizontal plane so that the mud can spill over the sides and down an inclined plane extending the full length of the feed pipe and sloping downward.

As the mud streams down the inclined plane, the vacuum in the vapor space causes the gases to leave the mud and to be withdrawn from the tank by the vacuum pump. The degassed mud, back to its normal weight, flows to the bottom of the vessel for exit. The mud flows from the bottom of the vessel through the tube at the left of the machine, which is a downspout, into the second mud tank. A hydraulically operated jet is located in this downspout. Mud at high velocity is pumped through this jet to lower the mud pressure here below the mud pressure in the degasser. In this way the mud is made to flow from the degasser in spite of the vacuum in it.

$$\text{Commercial speed} = \frac{\text{Meter drilled}}{\text{Drilling days}} \times 30.4$$

$$\text{Cycle speed} = \frac{\text{Meter age drilled} \times 30.4}{\text{Rig building + drilling + production testing}}$$

ADVANTAGES OF MAINTAINING THE QUALITY MUD FOR MECHANICAL EQUIPMENT

- ✓ It helps to enhance the useful service life of Mud pump expendables.
- ✓ It helps to eliminate cavitations problems of pumps.
- ✓ It helps to maintain volumetric efficiency of the pump.
- ✓ It helps to save the power.
- ✓ Erosion problem can be minimized.
- ✓ Acid corrosion of mud handlings can be avoided.
- ✓ Main component like fluid end, centrifugal pump housing and impeller can be saved from mud cut.
- ✓ Life of equipment can be extended.
- ✓ Man power usage can be reduced.
- ✓ Down time can be eliminated.
- ✓ Consumption of spares can be minimized.
- ✓ Money can be saved.

PUMPS

Pump is purely a mechanical device, which raises the energy level of various fluids by converting the kinetic energy imparted by its prime mover into hydraulic energy.

Pumps can be broadly classified into three types:

a. Centrifugal pump (dynamic / non-positive displacement type).
b. Rotary pump (positive displacement pump).
c. Reciprocating pump (positive displacement pump).

CENTRIFUGAL PUMPS:-

Centrifugal pumps employ centrifugal force for pumping liquids. Liquid coming in at the centre of the impeller is picked up by the vanes and accelerated to a high velocity by the rotation of the impeller and thrown out by centrifugal force into an annular channel or volute and the discharge. Centrifugal pumps are normally used for pumping water and liquids.

Law of centrifugal pump

$$Q \propto N$$

$$H \propto N^2$$

$$P \propto N^3$$

Higher specific speed, higher efficiency, high head, high flow is economical.

ROTARY PUMP:-

A rotary pump consists of a fixed casing containing gears, gerot, vanes, pistons, lobe and screws. It operates with minimum clearance in such a way that a positive displacement of liquid occurs with each rotation of the drive shaft. Rotary pumps are normally used for lubricating machinery and hydraulic application.

GEROTER PUMP:-

- ✓ No slippage
- ✓ It is used for instrumentation and automotive system.

GEAR PUMP:-

- ✓ Slippage is more
- ✓ It is used to pump the high viscous fluid like lubricant oil.
- ✓ Uniform flow so pulse is less.

VANE PUMP:-

- ✓ Pulse is more due to eccentricity of shaft.
- ✓ Balance is also a problem.
- ✓ Non-uniform flow.
- ✓ Slippage is less compare to gear pumping.

RECIPROCATING PUMPS:-

Reciprocating pump employs a piston in a cylinder positively displacing a given volume of fluid for each stroke. It is normally used in ONGC for pumping high viscous fluids like mud and crude oil.

Differences between positive and non-positive displacement pumps.

Sl.no.	Positive displacement pump (reciprocating pumps)	Roto-dynamic pumps (centrifugal pumps)
01	It runs at slow speed	It runs at high speed
	1. The discharge volume does not change with variations in delivery head. 2. The delivery pressure	1. The discharge volume decreases with increase in delivery head. 2. They can develop a

02	may rise dangerously if the delivery pipe is choked. 3. We cannot change the capacity or head by constant RPM. 4. We can change the capacity by increasing rpm. 5. We can change the pressure by changing cylinder liner.	definite maximum amount of head for a particular speed. 3. We can change the head; capacity without changing RPM by increase or degrease the suction and delivery pipe.
03	Losses due to slip or leakage in passage may occur.	No problem of losses due to slip or leakage in passage.
04	The water flow is pulsating.	There is continuous liquid flow.
05	There is high initial and maintenance cost. Maintenance is difficult and requires constant attention.	Low initial and maintenance costs. No continuous supervision required.
06	They are large in size and oblique in disposition.	They are compact and symmetrical design.
07	They are better suited for high heads over 60m and viscous liquids.	They are efficient for heads upto 60m in single stage. Mostly suitable for pumping cold and clean water.
08	Efficiency is as high as 85%	Efficiency is 60%

NOTE:

Power absorbed by a pump is almost directly proportional to discharge rate. However this relationship is true only for radial discharge centrifugal pumps.

MUD PUMPS:-

The main component of fluid circulating equipment for rotary drilling is mud pump. It provides the driving force that sends the fluid through the route that must travel.

The PT series mud pumps are horizontal, triplex, single acting, piston pumps. These pumps will provide a uniform flow over a wide pressure-volume range to meet any drilling requirement within its size capability. These pumps are categorized by the input HP rating. Detailed specifications of M/S BHEL/ M/S BPCL make mud pumps are given below.

Sl.no.	Description	Model: A850PT	Model: A1100PT
01	Rated in horse power	850HP at 160RPM	1100HP at 150RPM
02	Pump size (piston dia.x stroke)	7½" x 9" (9" stroke, single acting, horizontal)	7½" x 10" (10" stroke, single acting, horizontal)
03	Standard piston size	5", 5½", 6", 6½", 7" & 7 ½"	5", 5½", 6", 6½", 7" & 7½"
04	Gear ratio	4.48: 1	4.48: 1

05	Rated working pressure (delivery)	5000psi	5000psi
06	Rated working pressure (suction)	250psi	250psi
07	Testing pressure (delivery)	10000psi	10000psi
08	Testing pressure (suction)	500psi	500psi
09	Suction pipe diameter	8″	8″
10	Delivery pipe diameter	5″	5″
11	Weight	34669lbs	17000kg
12	Cross head clearance	0.015″ to 0.025″	0.40 to 0.60mm
13	Crankshaft end play	0.05″ to 0.06″	1.25 to 1.50mm
14	Pinion shaft end play	0.05″ to 0.06″	1.25 to 1.50mm
15	Cross head pin in cross head	0.000″ to (-) 0.003″(interference fit)	0.000 to (-) 0.075mm″(interference fit)
16	Jackshaft	0.01″ to 0.015″	0.25 to 0.38mm

17	Relief valve pressure setting	25% above the rated working pressure of liner size	25% above the rated working pressure of liner size
18	Serving period	6 months	3000 to 5000operating hours
19	Oil capacity of sump	85 gal	322litres
20	Operating temperature	90^{o}F to 180^{o}F	32^{o}C to 82^{o}C

Note:

- ✓ A850 PT (A-Series, 850 HP, P –Pump & T—Triplex)
- ✓ A1100PT (A Series, 1100HP, P- Pump & T—Triplex)

DISCHARGE VOLUME CALCULATION:-

The load on the piston rod determines pressure ratings, which is the product of the pressure multiplied by the area of the piston exposed to fluid pressure. The size of the liner limits the allowable discharge pressure, regardless of speed.

$$\text{Gal. Per. Rev.} = \frac{\text{Area of piston} \times (\text{Length of stroke} \times \text{Number of pistons})}{231}$$

Gal. per Min. = Gal. per Rev. x rpm

$$\text{BHP} = \frac{\text{GPM} \times \text{PSI}}{1714 \times 90\% \text{ Mech. Eff.}}$$

$$\text{Hydraulic horse power (hhp)} = \frac{P \times Q}{1714}$$

Where P = Delivery pressure in psi

Q = Fluid pumped in gpm

Hhp = Volumetric efficiency x Mechanical efficiency

= 90% x 80%

= 72% prime mover output power

THE SALIENT FUTURES OF MUD PUMPS:-

Mud pump is designed for heavy-duty service. The extreme volume-pressure capabilities of this pump are developed in an all-welded steel power frame. Double row spherical self-aligning roller bearings, support both crankshaft and pinion shaft, with straight roller bearings employed in the connecting rods at crank and crosshead ends. Crossheads are cast ductile iron, operating on replaceable upper and lower shoes in renewable shim adjustable guides. The connecting rods are two-piece design which permits separate installation of connecting rods into pump and in-frame assembly of connecting rods to crankshaft. The dual lubrication system is designed to provide constant trouble-free operation. The cascade oiling system will temporarily provide lubrication even in the event of oil pump failure. The three fully interchangeable and individually replaceable "L" shaped fluid cylinders afford easy maintenance. For time saving and convenience, the piston rods are threaded two-piece construction, which quickly disassemble to facilitate removal of pistons without disturbing the liner. Valves and valve seats are removed and replaced thru individual valve covers. This pump incorporates all features contributing to low cost, trouble-free maintenance.

WORKING PRINCIPLE OF MUD PUMP:-

The chain driven sprocket from the power source is attached to the pinion shaft and causes it to turn a smaller gear. The pinion drives a larger gear i.e. bull gear. The bull gear is attached to the crankshaft; the crankshaft turns to give a back-and-forth motion to the connecting

rods. The connecting rods are linked to the crossheads. The crossheads are connected to the piston rods and impart back-and-forth, or reciprocating, motion to the rods.

PULSATIONS EFFECT OF PUMP:-

The pressure pulsation in the pumps is due to:

1. Loss of effective suction head.
2. Fluid or hydraulic knocking.
3. Reduction of volumetric efficiency
4. Discharge line vibration.

SUCTION:-

Fluid knocking is closely related to insufficient suction head. The degree of such fluid knocking depends on the conditions of the pump suction. Fluid knock causes metal fatigue and therefore should be avoided. The mud tanks should be arranged to keep the suction line filled, the suction line should be short and straight, a pulsation dampener should be provided to reduce hydraulic hammer and a supercharging pump may be needed.

SUPERCHARGING:-

Centrifugal supercharging pumps increase suction line pressure. The increased pressure produces higher pump volumetric output and allows higher-speed operation, smoother discharge pressure, and other advantages.

PULSATION DAMPENER:-

A pulsation dampener absorbs discharge pressure variations and thus reduces peak pressures and permits smoother volumetric pump output. This action in turn minimizes vibrations in the discharge line and

the rotary hose and gives a more constant flow rate through bit nozzles. The dampeners should be installed as near to the pump as possible. Nitrogen charging pressure in the dampener must be held to the manufacturer's recommendation.

PRESSURE RELIEF VALVE:-

A pressure relief valve should be installed in the discharge line immediately next to the pump. Its primary purpose is to protect the pump when the discharge line, another part of the hydraulic system or bit nozzle becomes plugged.

IMPORTANT POINTS TO REMEMBER:-

1. When the pump alignment is achieved it should be reinforced by shear blocks or dowel pins.

2. Single acting pumps require a flooded or charged suction for proper performance. A net positive suction pressure, as provided by an adequate centrifugal charging pump, will aid in the filling of the fluid cylinders and reduce the erratic operation caused by cavitations. Generally, the charging pump should have a capacity equal to 1½ times that of the triplex pump.

3. The suction line should be as short as possible and the fluid velocity should not exceed 3 feet/second. Maintain the lowest possible velocity and the lowest possible pump speed to provide for maximum pump performance.

4. A suction stabilizer is recommended-installed as close as possible to the pump inlets.

5. Installed a discharge pulsation dampener as close to the pump as possible.

6. Installed a pressure relief valve ahead of any valve in the discharge line. It must be set at a pressure not greater than 25% above the rated working pressure of the pistons or plungers being used.

7. The pump is designed for **clockwise rotation of the crankshaft when viewed from the right hand side**. Right or left hand side is, determined by standing at the power end and looking toward the fluid end. Reverse rotation may be detrimental to the unit

8. The filling of oil may be accomplished by removing the breather on top of the crankcase.

9. If lubricant gets contaminated, change it immediately.

10. Maintain the temperature of lubricant within range.

11. Change the filter cartridge when the lubricant is changed.

12. Change the filter cartridge when the pressure across filter increases 15psi.

13. Clean the magnetic filter once each month.

14. Clean the lubricant strainer once each month.

15. "Tell tale" holes are provided in the valve chambers. Any leakage past the valve cover gasket will be discharged through these openings. If leakage is detected, immediately tighten the valve cover or replace the gasket otherwise fluid cutting or a wash out will occur.

16. If leakage occurs replace the wiper rings immediately and if necessary replace the crosshead extension. The sealing inner lip of the first wiper ring installed in the diaphragm housing must be directed inward (toward the power frame) to keep the lubricant

from being carried out of the crank case by the crosshead extension. The sealing lip of the second wiper rings (two numbers) installed in the diaphragm housing must be directed outward (toward the fluid end) to wipe foreign material from the extension rod.

17. Daily train water contaminant from trap.
18. The jackshaft assembly is provided to drive lubricating oil pump as well as manual rotation of crankshaft.
19. Cross head clearance is to be checked and adjusted once in six month.
20. Pre-charge pressure of nitrogen in the hydril chamber is 1/3 of mud pumps discharge pressure or maximum up to 1000psi.

PRE-CHARGE PRESSURE OF HYDRIL BALOON:-

slno	Mud pump discharge pressure in psi	Hydril pressure in psi
01	1500	350
02	2500	500
03	3000	700
04	4000	900
05	5000	1000

NOTE: Pre-charge pressure of hydril is not less than 20% of expected maximum delivery pressure.

ADVANTAGES OF RUNNING THE PUMP AT LOW SPEED:-

Infinite life could be expected at zero pump speed and zero life at infinite speed due to abrasive wear of expendables of reciprocating pumps is exponential not linear. Speed of the pump produce wear and shorten parts life.

The detrimental effect on parts life and efficiency of pump at

1. High speed
2. Short stroke
3. High discharge pressure
4. Low suction pressure

Fast speeds and short stroke result in high stroke reversal rate is a major cause of wear in reciprocating pumps handling abrasive liquids. If pump speed is reduced to half of rated speed, parts life improvement more than doubles longer stroke length contributions to greater parts life are effective because they decrease stroke reversal rate. At reduced speed for equal output results in significant cost savings from increases in the expected life of expendable pump parts. The piston speed below 200 fpm generally provides proportionally more trouble free hydraulic performance for all pump type and size.

The mechanical efficiency of single action triplex pump is 90% and double acting duplex pump 85%. In order to experience maximum savings, both pumps should be operated at equal rpm.

Advantage of low speed:-

1. Extended parts life
2. Reduced mechanical maintenance
3. Lower parts replacement costs.

Better to operate both mud pumps in equal rpm to enhance service life of expandable and the life of the pump itself.

DO:-

- ✓ Top up oil up to tip stick mark (preferably middle of low and high mark).
- ✓ Drain the water from trap.
- ✓ Safety valve pressure setting must be 20% more than maximum delivery pressure of liner used in the pump.
- ✓ Check the mud pump rotation. It should be clock wise direction when viewed from right hand side.
- ✓ Ensure both suction and delivery valves are open condition before starting the pump.
- ✓ Check the nitrogen pressure in the hydril and ensure within the limit.
- ✓ Delivery line must be anchored properly to avoid accident.

DON'T:-

- ✓ Don't run the mud pump with reverse rotation.
- ✓ Don't run the mud pump without proper setting of pressure relief valve.
- ✓ Don't run the mud pump without checking of oil level in the sump as there is no safety system for stopping the pump due to starvation of oil.
- ✓ Don't run the mud pump without opening suction and delivery line valves.
- ✓ Don't run the pump without nitrogen pressure.
- ✓ Don't run the pump without coolant for piston and liner.
- ✓ Don't run the pump with mud leakage from tell tale holes.
- ✓ Don't run the mud pump without supercharger.

GENERAL INFORMATIONS RELATED WITH DRILLING RIGS

1.TECHICAL SPECIFICATIONS OF BEACON WEIR MAKE WATER PUMPS:-

Sl.no,	Operating parameters	Units of parameters	Model BWC 50/80	Model DOB 80/100	Model DOC 100/125
01	Flow rate	M^3/hour	30	25	35
02	Flow rate	Liters/min	500	417	583
03	Flow rate	Gallons/min	110	91.7	128.3
04	Delivery head	Meters	100	75	85
05	Delivery pressure	Kg/cm^2	10	7.5	8.5
06	Delivery pressure	psi	142	107	121
07	Operating speed	rpm	3000	1460	1470
08	BHP obtained	hp	27.4	13.7	22.2
09	MHP recommended	hp	60	30	50
10	NPSH required	meters	4.6	5.6	3.8
11	Suction end	mm	80	100	125
12	Delivery end	mm	50	80	100
13	efficiency	%	40	50	49
14	Casing body	material	Cast iron	Cast iron	Cast iron
15	impeller	material	Cast iron	Cast iron	Cast iron
16	Stuffing box bushes	material	Cast iron	Cast iron	Cast iron
17	Glands	material	Cast iron	Cast iron	Cast iron
18	Shafts	material	EN-8	EN-8	EN-8
19	Shaft sleeves	material	Mild steel	Mild steel	Mild steel

2.TECHNICAL SPECIFICATION OF MISSION MAGNUM PUMPS:-

Slno	Parameter	Unit	Model 8″ x 6″x14″	Model 8″ x 6″x12.5″	Model 8″ x 6″x10″	Model 8″ x 6″x12.5″	Model 8 x6x14
01	Flow rate	Gpm	500-2000	500-1500	100-320	500-1800	500-2200
02	Delivery head	Feet	95-80	65-55	110-80	165-145	205-180
03	Speed	Rpm	1150	1150	1750	1750	1750
04	BHP	Hp	25-60	17-35	2-7.5	50-100	75-150
05	MHP	Hp	30-70	20-40	3-10	60-120	80-160
06	NPSH	Feet	3.5-15	3-15	2.5-7	4-20	4-20
07	Suction end dia.	Inch	8	8	3	8	8
08	Delivery end dia.	Inch	6	6	2	6	6
09	Efficiency	%	45-65	45-65	25-50	45-55	45-55
10	Casing body	Material	CI/CS	CI/CS	CI/CS	CI/CS	CI/CS
11	Impeller	Material	CS/SS	CS/SS	CS/SS	CS/SS	CS/SS
12	Stuffing box bushes	Material	CI	CI	CI	CI	CI
13	Glands	Material	CI	CI	CI	CI	CI
14	Shaft	Material	SS416	SS416	SS416	SS416	SS416
15	Shaft sleeve	Material	SS416	SS416	SS416	SS416	SS416

3.CUMMINS ENGINE RATING FOR GENSET APPLICATION:-

ENGINE MODEL	BHP	@1500 RPM/KW	KVA
NTC 495 G	154	100	125
NT 743 G	205	128	160
NTA 855 G	306	200	250

These values are calculated at 0.8 P.F and Volts 440

N, K ---Series

T—Turbocharger

A—After cooler

G—Gen set application

P--- Production application

C –Construction application

IMPORTANT PARAMETERS:-

Maximum coolant temperature ---95^{o}C

Normal engine oil pressure at 105 ^{o}C---3 to 7 kg/cm^{2} (at rate rpm)

---- 1 to 2 kg/cm^{2} (at low idle)

pH value should be between 8.5 to 10

ENGINE EXHAUST:-

The engine exhaust is a good indicator of engine operation and performance. A smoky exhaust may be due to a poor grade of fuel, dirty air cleaner, overhauling due or poor mechanical condition

4.FUEL SPECIFICATIONS AND THEIR USAGES:

CETANE NUMBER:-

The cetane number refers to the property of igniting the fuel easily. If the fuel is at a high cetane number the fuel can ignite easily. It can then ignite at a low temperature. If the cetane is low, the temperature required to ignite the fuel is high. This is not desirable. Also, if the cetane number is low, there is a possibility for the fuel to knock. A high cetane number ensures that the fuel will ignite and burn immediately after the fuel is injected.

Sl.no.	Type of fuel	Properties
01	LPG (liquefied petroleum gas)	1. It is a mixture of butane and propane gases. 2. It is liquefied under normal ambient temperature and moderate pressure. 3. It is a clean burning, non-poisonous, dependable, high calorific value fuel. 4. Very low sulphur content. 5. It is mainly used as a domestic fuel. 6. It is also widely used in industries where very fine degree of temperature control is required.
02	M.S (Motor spirit	1. It is used as fuel in spark ignition engines. 2. It is mainly used in two stroke and four stroke engines of automobiles. 3. It is a highly refined fuel and possesses good anti-knock and volatility characteristics with appropriate stability.
	ATF	1. It is a highly refined transparent fuel having

03	(aviation turbine fuel)	extremely good oxidation and thermal stability with a very low pour point. 2. Application: fuel for jet and turbo propelled aircrafts.
04	HSD (high speed diesel)	1. Application: fuel for medium and high-speed engines (above 750 R.P.M.)
05	HF-HSD (high flash high speed diesel	1. HF HSD meets the same specification as normal HSD except that it has a flash point of 66ºc minimum against 32ºc for normal HSD. 2. Sulphur percentage is limited to max. of 1% 3. **Application**: It is specially recommended for use in diesel engines for naval applications and merchant navy.
06	LSHF-HSD (low sulphur high flash high speed diesel)	1. It is similar to HF HSD except that sulphur percentage is limited to 0.2%. This is specially recommended for use in certain diesel engines for naval applications and merchant navy. Where low sulphur fuel is recommended
07	LDO (light diesel oil)	1. LDO is a blend of distillate fuel with a small proportion of residual oil, primarily recommended for slow speed diesel engines operating below 750 rpm 2. **Application**: Agriculture, marine, furnaces and boilers.

5.DIFERENT SIZE AND RANGE OF PRESSURE GAUGES USED IN THE DRILLING RIGS

Sl.no	Name of the equipment	Application Of gauge	Dial size	Range	Thread size	Mounting (Pipe/panel)	No
01	Mud pump	Lub.oil pr.	2"	0 to 10 kg/cm^2	¼" NPT	Pipe	2
02	Mud pump	Lub.oil pr.	4"	0 to 10 kg/cm^2	½" NPT	Pipe	2
03	Mud pump	MP line pr.	4"	0 to 350 kg/cm^2	2" NPT	Pipe	2
04	De -silter	Input pr.	2"	0 to 80psi	¼" NPT	Pipe	1
05	De-silter	Input pr.	4"	0 to 80psi	½" NPT	Pipe	1
06	De-gasser	-Ve pr.	4"	0 to 30psi 0 to 30"	½" NPT	Pipe	2
07	De-sander	Input pr.	4"	0 to 10 kg/cm^2	½" NPT	Pipe	2
08	Air-tank	Air pr.	6"	0 to 20 kg/cm^2	½" NPT	Pipe	1
09	Air-dryer	Air pr.	6"	0 to 14 kg/cm^2	¼" NPT	Pipe	2
10	Air-dryer	Regulator pr	2"	0 to 7 kg/cm^2	¼" NPT	Pipe	1
11	Air receiver tank	Air pr.	2"	0 to 16 kg/cm^2	¼" NPT		1

6.PNEUMATIC VALVES OF DRAW WORKS

Sl.no	Description	Location	BHEL Part Number	Wabco Part Number
01	Valve HC-2-SX	Rotary/ Break out cat head	1-96615-3-0022	P52518-3
02	Valve H-2-EX	Spinning cat head	06-000-085	P50925-2
03	Valve 2HA-2	Drum low/high	3-96615-3-0029	P59335

04	Valve 2HA-1	Neutral brake	3-96615-3-0030	P59331
05	Valve 2HA-1	Sandreel	3-96615-3-0030	P59331
06	Valve 2HA-1	Cat shaft disconnect	3-96615-3-0030	P59331
07	Valve 2HK-1R	Emergency brake	-	2410 (G.H.Bear)
08	Valve 2HA-2Z	Kelly spinner		
09	Inter lock valve	D/W	06-000-811	PD2-31-9820
10	Relay valve	D/W	06-000-662	P55162
11	Quick release valve	Low/high clutch	06-000-391	P52935-3
12	Quick release valve	Rotary clutch	06-000-391	-
13	Quick release valve	Cat head	-	-
14	Quick release valve	Sandreel clutch	-	-
15	Rotor seal	Low clutch	4- 96611-3-0010	-
16	Rotor seal	High clutch	06-001-857A	-
17	Rotor seal	Rotary clutch	06-001-857A	-
18	Rotor seal	Sandreel clutch	4-96614-3-0078	-
19	Check valve	D/W	06-000-667	P55026
20	Pressure regulator	Air supply	06-000-940	-
21	Transmission valve 2HA-2	Gear shifter	-	-
22	Cam -valve	Crown-o-matic	-	2412(G.H.Bear)
23	Shuttle valve	Crown-o-matic	-	2413(G.H.Bear)
24	Main valve	Crown-o-matic	-	2669(G.H.Bear)
25	Check valve	Crown-o-matic	-	2467(G.H.Bear)
26	Over ride valve	Crown-o-matic	-	2411(G.H.Bear)

27	Brake cylinder(main)	D/W	-	2414(G.H.Bear)
28	Air Cylinder	Rotary Brake	06-001-264C	-
29	Air cylinder	Low drum drive	06-001-264	-
30	Air cylinder	Transmission	06-010-083	
31	Air cylinder	Neutral brake	06—001-264	
32	Valve	Rotary brake	06-000-561	
33	Transmission valve	Transmission valve	TP5-2049	PD20045
34	Air cylinder	Transmission	06-000998	
35	Rotor seal	Rotary clutch	06-001855	
36	Relay valve			P57431
37	Inter lock valve			PD20000-0020
38	Inter lock valve end kit			PD20000-0098
39	Over ride valve			3014(GH)
40	Main valve (crown-o-matic)			3013(GH)
41	Cylinder	Air brake	OE975102000	54-1-85-0131

BIBILOGRAPHY

- Hoisting Equip. Operation and maintenance manuals –BHEL
- Operation and maintenance manual ------Caterpillar, USA
- Operation and maintenance manual----Cummins India Limited
- Operation and maintenance manual--- Hindustan powerplus
- Operation and maintenance manual--- Elgi Equipment Limited
- Operation and maintenance manual--- Khosla Pnuematic
- Selection, operation & maintenance of pumps--- NPC
- The reciprocating pump second edition--- Miller. Kricker
- Mud equipment manual ---George S. Oremsby &Walter, Liljestrand
- Lubricant manual----IOC.
- Lubricants manual- ----HPCL.
- Course material ---------- FTI
- Operation and maintenance manual (TDS) --- VARCO
- Operation and maintenance manual (ID) ----BHEL